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THE GRASSLANDS OF THE ARGENTINE AND PATAGONIA

by

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FOREWORD AND SUMMARY

The tour of South American grasslands upon which this report is based was made during March and April, 1938, after the conclusion of a visit to the Falkland Islands. A comprehensive report dealing with the latter has been presented to the Secretary of State for the Colonies (**1**). The present report deals briefly with the zonation of pastoral and agricultural lands in the Argentine and Patagonia, and discusses in general the potential and immediate scope of development within each zone. The grasslands and other types of vegetation in Patagonia may largely be regarded as naturally occurring formations on which a sheep ranching system has been superimposed. This has resulted in creating changes in the natural vegetation although it still bears the general features of the primitive vegetation. The Patagonian grasslands as a whole are devoid of native herbaceous legumes. The grasslands of the Argentine Provinces including those of the La Plata basin, by comparison with those of Patagonia, have been much more intensively farmed with the result that the natural pampas grasslands have been replaced largely by pastures that are best described as "induced exotic." The herbaceous flora found in these grasslands consists mostly of species not present to any great extent in the original natural grasslands, and many of the species, e.g. *Cynodon dactylon*, are of exotic origin. In many cases too, the leguminous flora is exotic. From the viewpoint of intensive farming one of the most interesting developments in the La Plata region is that of fattening cattle on lucerne. The basis of this practice is the temporary ley chiefly based on lucerne together with the use of cereal crops for out-of-season grazing. The scope for immediate and intensive agricultural development is immense within these rich lucerne areas, but elsewhere in the Argentine and in Patagonia generally, there are many technical difficulties which prohibit any extraordinary immediate expansion in pastoral output. This of course is true in arid and sub-arid areas generally. The finding of an appropriate leguminous plant which would establish itself in these areas would, however, have an enormous influence upon output and further development over very large tracts of country.

The tour of South America was made possible by a Travelling Research Scholarship granted by the British Ministry of Agriculture and was greatly facilitated by a number of British and other companies with an agricultural interest in the Argentine and Patagonia. Through the courtesy of Sir Richard Cooper, the greatest possible assistance was given by Messrs. Wm. Cooper and Nephews (South America), Ltd., who operate in South America for Messrs. Cooper, McDougall and Robertson, Ltd., England. Messrs. Cooper and Nephews (South America), Ltd., were not only responsible for providing me with many necessary introductions, but also assisted me greatly in the detailed preparation of my whole itinerary ; when there were no other means of transportation, they very kindly allowed me to travel in their cars, and often placed their advisory and field staff entirely at my disposal. Through the courtesy and good offices of Messrs. Cooper, I was able to do a great amount of

work and to see very large and scattered areas of country in the minimum of time. Indeed, it would be entirely true to say that without the help of Messrs. Cooper it would not have been possible to follow the very comprehensive itinerary which was carried out. I can only add my gratitude for the active co-operation which I received from every member of their staff with whom I came into contact throughout South America.

I am indebted also to the large number of station-owners and others with whom I made personal contact during my tour, and many of whom went to great trouble in order to show me over their holdings, discussing freely with me their problems, their hopes and their difficulties in connexion with grasslands as well as with land improvement generally.

A complete list of persons concerned is not possible here, but in addition to the Station owners and managers whose names are shown in the text, I am greatly indebted to the following :—Mr. T. C. Betteridge, Mr. D. Leslie, and Mr. W. Keys, all of Messrs. Wm. Cooper and Nephews (South America) Ltd., Buenos Aires, Mr. Payne of Messrs. Wm. Cooper and Nephews (South America) Ltd., Montevideo ; Mr. John Dick, of Messrs. Dick and Bravo, Punta Arenas, Mr. Greer, General Manager, Sociedad Explotadora de Tierra del Fuego, Punta Arenas, Mr. C. R. Buxton, Messrs. Jacomb Hoare and Co., London, and Señor Raimundo Nieves, Department of Agriculture, Buenos Aires.

There are many others which could be added, to all of whom I am grateful for their generous assistance, and for the information that was so freely given whenever sought.

I am indebted also to the Ministry of Agriculture and Fisheries for granting me official facilities which made the task of large scale travelling in foreign lands both easier and more free. My sincere thanks are also due to Sir George Stapledon for his interest and general planning of the tour. I would also wish to thank the staff of the Herbage Bureau at Aberystwyth for seeing this bulletin through the press ; and also Miss I. D. Rees and Mr. Morlais Hughes for their valuable contributions in assisting me to prepare the final manuscripts.

ROUTE FOLLOWED

(*See sketch map facing p.* 49)

I landed at Tres Puntes (near Punta Arenas) from the Falkland Islands, and visited a number of sheep stations in Southern Patagonia. It was not possible to visit the important sheep grazing lands of Tierra del Fuego, which lie to the south of the Straits of Magellan, but at Punta Arenas I was able during various interviews to discuss fully the problems of this large island. It would appear that these problems are somewhat similar to those of the mainland stations immediately to the north of the Straits including certain stations which were visited (Fenton, Condor, etc.).

From Punta Arenas (on the Straits of Magellan) I travelled into the Southern Andes, and thence eastwards over the grasslands of Southern Argentina to the coast at Gallegos and Condor. From there I proceeded northwards along the coastal and sub-coastal grasslands, visiting a number of typical stations on the way. At Trelew, in the lower valley of the Chubut, and the home of the original Welsh Colony in Patagonia, I proceeded inland, passing through the rich irrigated lands of the Chubut Valley. The route followed the Chubut River for some 80 miles inland, and then crossed typical scrub grasslands until the Andes were again reached at Leleque. From there I turned northwards through typical Andes and Andes foothills to Pilcañeu, where I was able to see a good deal of the local grasslands running up into the heart of the mountain range.

From Pilcañeu my route took me back to the Atlantic coast, a distance of some five hundred miles (west to east), thence northwards through the rich agricultural lands of the Province of Buenos Aires to the capital city of that name. From Buenos Aires I took river boat up the Uruguay River to Concordia in Entre Rios. Here my itinerary and time table received the first setback. Because of heavy rains, accompanied by floods, it was impracticable to proceed into the northern part of the Province of Entre Rios, or into Corrientes ; the latter Province is important for its cattle and sheep rearing. I therefore saw as much as possible of middle and southern Entre Rios, and thence proceeded into the Provinces of Sante Fé, Córdoba and La Pampa. Parts of Entre Rios, Córdoba and Santa Fé contain rich agricultural lands (maize, sunflower, wheat, linseed, lucerne and other crops are grown), while the eastern part of La Pampa contiguous to the Province of Buenos Aires also provides some rich grazing and corn land. There are, however, considerable areas of wind-eroded land in this latter area. From La Pampa I returned eastwards through the Province of Buenos Aires to the city of Buenos Aires itself.

The tour, therefore, covered Patagonia and the Argentine in a south to north direction from the Straits of Magellan (Lat. 53°S.) to Entre Rios (Lat. 31°S.), a distance of over 1,500 miles as the crow flies, while three large sweeps were made into the grasslands of the interior, the Andes being touched at a number of points (near Punta Arenas, at Sierra Castillo, at Leleque, Maiten and Pilcañeu). The tour, therefore, covered most of the typical grassland and agricultural areas of Argentine and Patagonia, with the exception of the monte (= partially forested) country of sub-tropical northern Argentine. The completely arid foothills and plains of the western provinces of the Argentine (Mendoza and San Luis) were also not visited.

1938.		No. of miles traversed.
March 14 (2 a.m.)	Arrived Punta Arenas. Interviews with business men connected with farming in Patagonia. Visit to Frigorifico at Tres Puntes (Messrs. Gildermeisters). Grassland tour along Straits of Magellan and to Fenton sheep station	80
15	Returned to Punta Arenas. Further interviews	70
16	Left for Penitente, Natales, Bories and Sierra Castillo (sheep station) ..	170
17	Around Sierra Castillo and thence to Las Vegas and Gallegos ..	180
18	Chymenaiki and Condor (sheep stations). Discussions with interested men in Gallegos	100
19	Inspection of Condor station and returned Gallegos	100
20	Left Gallegos early for Moyaiki Chico where inspected the station. Proceeded to San Julian	260
21	All day on Estancia Coronel near San Julian	60
22	Left San Julian for Comodoro Rivadavia	330
23	Comodoro Rivadavia to Camarones (Lochiel station)	150
24	Lochiel to Trelew and the Chubut Valley (Welsh Colony). On to Las Plumas after dark	260
25	Las Plumas (in Chubut Valley) for Esquel and Tecka districts, visiting farms and settlements en route	270
26	On to Leleque station, which was inspected	80
27	From Leleque to Maiten and then to Pilcañeu	120
28—29	Inspection Pilcañeu lands, and discussions	40
30	Pilcañeu to hill lands (high rainfall) in Andes around Bariloche and Llao Llao. Left by train for Buenos Aires	100
31	Train to Buenos Aires via San Antonio, Patagones and Bahía Blanca	1000
April 1—2	Arrived Buenos Aires. Interviews and discussions with various officials and business men. Left by night river boat for Concordia	
3	Arrived Concordia	400
4—5	Visited various cattle stations (estancias) in Entre Rios	200
6	All day train journey (7 a.m. to 7 p.m.) Concordia to Parana ..	240
7	Parana to Sante Fé, Rosario, Gasilda, and Venado Tuerto. Visited Estancia La Elena	250
8	Venado Tuerto, Rufino (Estancia Laguna del Monte) and Buchardo	180
9	Buchardo (Estancia San Foin), Huinca Renanco and General Villegas	150
10	General Villegas, Elordi (Estancia La Catalina) and Trenque Lauquen. Night train to Buenos Aires	120
11—14	Arrived Buenos Aires. Interviews with various business men interested in agriculture, officials British Embassy, Sub-Secretary, Director and other officials of Argentine Ministry of Agriculture. Visited Botanic Gardens and one of the largest Argentine Frigorificos (the Anglo killing factory)	
14 (6.0 p.m.)	Sailed from La Plata for London	
		4,910

INTRODUCTION

The Argentine Republic consists of fourteen provinces (*provincia*) and ten territories (*gobernacion*), these twenty-four units comprising the main political divisions. The distinction which has been made in the body of this report between Patagonia and the Argentine proper is a real one in the agricultural sense ; in a broad, general way, it may be said that Patagonia is chiefly sheep ranching country carrying a vegetation of open tussock grasslands in the far south, or shrub steppe, as in mid and northern Patagonia. In the Argentine proper, cattle are more important than sheep, although numerous flocks aggregating to many million sheep are to be found in this area also. The vegetation consists either of grass steppe, as in the Province of Buenos Aires, or sub-tropical savannah intermixed with open grassland. Patagonia occupies the southern third of the country, and for the purposes of this report includes the territory of Magallanes comprising southernmost Chile, as well as the five Argentinian territories of Neuquen, Rio Negro, Chubut, Santa Cruz and Fuego.

The Argentine Republic as a whole covers about 690 million acres (**2**), is about twelve times the size of Great Britain, and equivalent to about two-fifths of the area of Australia. Only a small part lies within the tropics. The population is upward of twelve million people, based originally on Spanish blood, but by now extremely cosmopolitan though still preponderantly Latin.

Climate

Having regard to the great length of the country, which stretches through 33 degrees of latitude (the farthest point south lies in about latitude 55°S.), it is obvious that a wide range of climatic types is to be found within its boundaries. The climate is subtropical in the far north, the eastern central portions have a Mediterranean climate, while the south is cold temperate.

The zonation of rainfall incidence between the different areas of the country is an important factor. In the Argentine proper, that is, from the Province of Buenos Aires northwards, the heaviest rainfall is in the east, whereas many of the western districts receive very low precipitations, and are extremely arid, as in the provinces of Mendoza and San Luis. In Patagonia, that is, southwards from about the latitude of Bahía Blanca (39°S.), the prevailing winds are westerly ; the western districts abutting on the Andes therefore receive the heavier rains, while the rainfall on the Atlantic coast is below 20 in. per annum everywhere, and below 10 in. per annum over considerable areas. In Patagonia, therefore, the more arid vegetational types are found along the Atlantic seaboard.

The Andes run along the whole length of the Republic from north to south, and separate it from Chile. Many of the peaks in the Andes rise above 10,000 ft. and are permanently snow clad. Within the Patagonian Andes, there are numerous fertile

valleys at elevations up to 3,000 ft. above the sea. Along the Andes foothills also from Neuquen southwards, there are large fertile stretches with fairly cool temperatures and often with an annual rainfall of 20 in. or more.

Stock and Crops

The number of sheep, cattle and horses in the Republic, according to the 1930 census, was as follows :—

sheep, about 44,500,000 (of which one-third were in Patagonia),
cattle, about 32,200,000 (chiefly in the Argentine proper),
horses, about 9,800,000.

In addition there were roughly 3.75 million pigs and about 5.5 million goats.

The 1933-34 crop returns show the following acreages under the chief arable crops :—

	Approximate acreage
Wheat	19,700,000
Maize	16,100,000
Linseed	6,900,000
Oats	3,600,000
Barley	1,800,000
Rye	1,800,000
Lucerne	13,400,000

The Argentine is the leading lucerne-growing country in the world. The area under lucerne increased steadily from 1872 (when the aggregate acreage under the crop was only about 250,000 acres) to the peak acreage of 20,900,000 acres in 1920-21. Since that year the area has fallen to the figure for 1933-34 given above. Nieves (**3**) estimates that 37.6 per cent of the total area of the country is capable of cultivation, but that only 9 per cent is in fact cultivated.

It is probably true to say of the Argentine that because of the vast length of the country in a north to south direction, and because of the variability of rainfall and climate generally in different districts, practically every agricultural and pastoral crop is represented within the confines of the country. Sugar, cotton, bananas and other tropical crops are grown in the north ; oranges, grapes, apples, maize, linseed, sunflower, wheat, oats and rye are each important crops in the La Plata Basin, while the pasture types range from tropical scrub and forest grasslands to natural grasslands (steppe) on the pampa of the Plate, and to the shrub steppes of central Patagonia. Further to the south are the natural cold temperate tussock grasslands (grass steppe) of the *Poa-Festuca* group, while there is true rain forest in parts of the Andes. The natural and semi-natural grasslands carry cattle (chiefly in the north) and sheep as the two most important classes of livestock. In and around the Provinces of Buenos Aires, Entre Rios, Sante Fé and Córdoba are to be found the rich cattle fattening lands largely based on lucerne (alfalfa) and the temporary ley. The aggregate acreage of lucerne here is large and the output per acre is high, but

compared with the size of the Argentine as a whole (or even the Province of Buenos Aires as a whole) the acreage under lucerne and ley farming is negligible. From the points of view of grassland improvement and an increased output of livestock products, it is on this class of land that the greatest immediate development could take place. There can be no doubt that in the Province of Buenos Aires, and the adjacent ones to the north and north-east, there lies some of the potentially richest grazing land in the world. It is an important fact, too, that large areas of this land could be developed and output greatly increased, particularly if modern knowledge regarding seeds mixtures, manuring and grassland management was to be applied. Were this land to be properly developed, it has the potentiality of vast output as a reservoir of human and animal food. Looked at from the view of closer range policy, it also has the potentiality for serious competition with the agriculture and livestock industry of Great Britain and the British Dominions and Colonies, particularly Australia and New Zealand.

The provinces of the Argentine have concentrated their livestock farming upon the feeding of cattle, and in so doing have not in the past come into any material competition with the dairy industries of Australia and New Zealand. The Province of Buenos Aires itself could, however, with proper planning, develop an intensive dairying industry or a prime fat lamb industry. There are other possibilities in the development of the pastoral industry in subtropical Argentine, and in colder Patagonia, but here the problems present technical as well as other difficulties, and the potentiality for development is probably not nearly so great as in the temperate areas of high rainfall around the Basin of the Lower La Plata (Buenos Aires, Entre Rios, Santa Fé and Córdoba provinces).

Up to the present, the La Plata Basin has been perhaps a more serious competitor of the British than of the Dominion farmer. A development of the dairy industry in the Argentine, however, would be a serious matter for New Zealand. The latter Dominion now has a well organized dairy industry, and has taken steps to increase output and to decrease costs of production by improved grasslands. The potentiality of further increased production in New Zealand is, therefore, thereby reduced, while the Argentine provinces have on the other hand done little either towards grassland improvement or building up a properly organized dairy industry. With her soil and the climate, the Argentine possesses an untapped reserve whereby she can become a most important producer of dairy produce without doing more than put into effect the lessons in technique of grassland improvement practised in this country or in New Zealand.

THE GRASSLANDS—GENERAL CONSIDERATIONS

The Argentine, together with Patagonia (parts of southern Patagonia are in Chile), may be divided into a number of pastoral *cum* agricultural zones as follows :

1. Tierra del Fuego and the coastal strip adjacent to and north of the Straits of Magellan.
2. The natural grasslands (grass steppe) of southern and western Santa Cruz.
3. The grasslands and forest country of the Andes foothills.
4. The shrub steppe and desert scrub of northern and central Patagonia.
5. The irrigated lands (Chubut, Rio Negro, Senquel and Sarmiento).
6. The open grasslands (pampa) and agricultural districts of Buenos Aires, Santa Fé, Entre Rios, Córdoba and Corrientes.
7. The arid and semi-arid western provinces of La Pampa (west and south), Mendoza, San Luis and San Juan.
8. The subtropical scrub and open grassland of northern Argentine.

Each of these zones is outlined on the sketch map facing p. 49, and is discussed below in relation to its vegetation, agricultural or pastoral practices, and potential development.

Zone 1. Tierra del Fuego and the coast of the Straits of Magellan

(*See figs.* 1 *and* 2)

This is a region of open grassland with ridges of forest or scrub. Where the rainfall is above 20 in. per annum there is a good deal of beech (*Nothofagus*) forest. The forest cover tends to occur chiefly on ridges and undulating ground where the soil is relatively thin. The valley flats (= " vegas ") which separate the ridges are usually under natural tussock grassland. The flats are probably old lake bottoms. The soil is deep, obviously fertile, sometimes inclined to be too wet, in which case it may require drainage. Sometimes shallow peat is formed and there is nearly always underlying clay or heavy silt. The vegas of southern Patagonia have their equivalent in the " green valleys " of the Falklands, and in many cases the two are floristically similar. The flora of the vegas on Fenton Station, near Punta Arenas, for example, is dominated by *Juncus scheuchzerioides*, a species which is often the chief element in some of the Falkland valleys. The Patagonian vegas usually cover a larger proportional acreage on a holding than does the Falkland valley. In both countries these similarly constituted flats provide good grazing lands, and are acknowledged to be superior in this respect to the surrounding grazings. One outstanding characteristic of the vegas flora is the complete lack of clover and other legumes. The sward is usually grassy, or grasslike, and forms a tight mat without any bare soil showing in plan. The vegas thus differ markedly from the ridge lands and undulating country where there is nearly always a high proportion of bare earth. The flora is restricted to a few dominant species and the miscellaneous herbs are not abundant.

The ridges and undulating lands carry a certain amount of bushes, shrubs and sometimes trees. There is usually a ground cover of grasses (fescue and *Poa* tussocks), which show close affinity to those of the grass steppe (Zone 2). Fachinal bush,* which grows in this association, is another plant showing affinity with the Falkland flora, being widely distributed throughout Falkland grasslands.

Practically the whole pastoral industry of this zone is based upon sheep (wool and meat). The predominant breeds are Corriedale and Romney, the latter having been superseded to an appreciable extent by the former in the effort to cater for finer wool and heavier clips. At one time wool was the staple crop, but since the advent of freezing works ("frigorificos") both lamb and mutton are killed for export. The pastoral industry in this zone has important British connexions. The station managers are almost exclusively British (including New Zealanders and Australians) or of British parentage. Many of the companies are, however, Argentine or Chilean owned, but often administration is in the hands of British managers, and others.

The carrying capacity of the sheep stations is about one sheep per 1.5 to 3 acres, but the vegas contribute appreciably to this figure. As the average vega must have a carrying capacity of well over one sheep per acre, the average carrying capacity of the station as a whole will depend upon its proportion of vega. It is difficult to assess the actual carrying capacity of the ridges and the grass *cum* shrubs country within the zone, but it is likely to be about one sheep to about five to six acres.

On the whole, sheep are carried in good health, though many stations drench for stomach worms. The rainfall is about 12 to 25 in. and the growing season is relatively short (October to April). The whole area is windswept. Low temperatures with snow are experienced during the winter months. There is practically no conservation of fodder, and the pastoral system is of the ranching type.

Grassland Improvement and Possibilities

Clovers are infrequent in the existing herbage, and large scale improvement is unlikely until means are found whereby they can be successfully introduced. It is fairly certain that these grasslands would respond to dressings of phosphates, but these are unlikely to provide any worthwhile improvement unless applied to clovery swards. This at least has been the experience on similar grasslands elsewhere (for example, New Zealand, Australia, U.S.A., Canada). Apart from the clovers, these grasslands would benefit by the introduction of new grasses and herbs as well as by the promoting of increased development of the better indigenous grasses and non-gramineous plants. Only tentative suggestions can be made with regard to new grasses; these would include Yorkshire fog, timothy, *Phalaris tuberosa*, red fescue, cocksfoot, various *Agropyron* spp. (wheat grasses) and *Bromus inermis*, all of which are definitely more leafy and therefore more nutritious than the majority of the native grasses. It would also appear from experience of Falkland plants that many of these introductions may have a higher food value generally, and a higher mineral status than the native grasses. Again, there is the question of miscellaneous herbs which we now know to be richer in minerals than any of the grasses and clovers.

*See p. 46 for Latin names of plants.

If plants such as ribgrass, dandelion, yarrow and catsear could be successfully introduced into the existing grasslands, they might play an important part in stock nutrition. What is wanted is not so much plants (grasses and non-grasses) with a longer growing season, as plants that will remain green and succulent for a longer period into the autumn and winter—in other words, plants which can make good summer and autumn growth and then carry that growth forward into the winter as edible and nutritious leafage.

This would provide one means of conserving summer growth *in situ* for feeding off in the winter and early spring. Another method with the same object would be to grow special crops, such as lucerne, for cutting and storing for the winter. There is no adequate reason why lucerne properly inoculated, and appropriately manured and managed, should not grow in selected areas throughout Southern Patagonia, where it would provide a reserve of valuable feed for winter use.

There are therefore possibilities of development in the grasslands of this southern zone, but it is very doubtful if such a development can take place within the near future, partly because the technical knowledge is not available, and partly for general economic reasons.

Zone 2. The natural grasslands of southern and western Santa Cruz

(*See figs. 5 to 8*)

This zone stretches from about the latitude of Gallegos in the south, to north of San Julian, and occupies some thousands of square miles of land surface. It may be described as typical grass steppe with occasional patches of thorn and scrub (mata negra, mata verde, etc.), but always with a more or less grassy base. The vegetation is akin to the fescue and *Poa* tussock lands of New Zealand and Australia, although the winters are probably longer and colder than in either of those countries. Sheep farming is the only industry, chiefly wool production, but wherever the stations are within easy reach of the " frigorifico " (that is, particularly along the coast—there are freezing works along the Atlantic and Pacific coasts), killing for lamb and mutton takes place. Corriedales and Romneys are again the predominant breeds of sheep. The carrying capacity of these grasslands is one sheep to about 4 to 6 acres—typical large scale ranching, with the larger stations occupying up to a quarter of a million acres. There is a definite attempt on the part of the Argentine Government to restrict the size of holdings, especially in the more accessible parts of this zone, but there is always the danger of restricting the acreage to uneconomic levels. Under present conditions, it is probable that holdings of less than 10,000 acres (carrying say 2,000 sheep) are too small.

Nothing is being done in this zone to replenish plant foods which, under the " frigorifico " system, are bound to be draining away from the land, and it is unlikely that specific manuring will acquire any appreciable importance in the coming decades.

Measures of grassland improvement must, as in Zone 1, be concerned with the closer subdivision of paddocks, possible introduction of new plants, including the legumes (there are no native clovers), and the conservation of feed for winter. Trials now in progress, including some begun at the suggestion of the writer, suggest that

lucerne can be successfully grown on selected sites and over a considerable area of these lands, but it appears to be necessary to inoculate with an appropriate bacterial culture. If lucerne can be grown, then appreciable development might take place in this zone, for lucerne if established in the open camp would provide a very valuable asset both for grazing and for fodder conservation, as well as in helping to maintain a higher level of soil fertility. The rainfall in this zone is about 10 to 12 in. per annum ; the winters are long and cold, periods of snow occur and there is a persistent high wind.

Zone 3. The grasslands of the Andes foothills

(*See figs.* 3, 4, 11, 12 *and* 13)

These occupy a narrow strip of country on the western border of the Argentine, stretching from the territory of Neuquen in the north practically to Punta Arenas in the south, i.e., through about 14 degrees of latitude (say 1,000 miles). This belt is nowhere more than about 10 or 15 miles wide ; being situated among the high mountains, it receives appreciably more rainfall than the lands to the east (the prevailing winds are westerly, off the Pacific Ocean). The primitive vegetation varies from dense forest with southern beech (*Nothofagus*) in the south and pines (*Cupressus* et al.) farther north, as in the region of Bariloche, to open grassland in the valleys. The valley lands in this belt often lie at a fairly high elevation (up to 3,000 ft.), while the high Andes tower above them. Because of the fairly high rainfall, parts of this belt provide productive and fertile grazing lands. Sheep are the chief domestic livestock, and the problems are somewhat similar to those of Zone 1 ; although the country is less accessible to the main outlets, the problems connected with land development and pasture improvement are easier to solve than in the drier eastern zones. White clover grows almost like an indigenous plant and there is no reason why ryegrass, cocksfoot, timothy, red clover, lucerne and other of our grassland plants should not thrive over considerable areas in the Andes valleys. There is much scope for development in this zone, which although only a narrow belt, represents a considerable acreage of country. With an intensified improvement of grasslands, much closer settlement would be possible, and in places irrigation could be practised, as has already been done at the Welsh Colony at Esquel, which lies within this belt. The area might become of competitive importance in world markets in the production of fat meat and dairy produce. It is at present handicapped by lack of transport and other facilities. In the northern part of the zone, a new north-south railway is being built by the Argentine Government to connect that part of the area direct with ocean ports at Buenos Aires and Deseado.

Zone 4. The shrub steppe and desert scrubs of Central and Northern Patagonia

(*See figs.* 9 *and* 10)

This covers a very large block of country and includes practically the whole of the territories of Rio Negro and Chubut, as well as the northern half of Santa Cruz. The vegetation may be described as shrub steppe. Many of the bushes are very spinous and some are said to be poisonous to stock. The scrub cover may be fairly

dense in places, but is usually open enough to permit one to walk between the bushes with ease. Sometimes there are only scattered bushes, and in places no tall scrub occurs. Taking the area as a whole, the grass flora is sparse ; in some cases there is practically no grass, or indeed any vegetation at all (other than an ephemeral one after heavy rains) at ground level. The area carries in the aggregate, and because of its huge area, a considerable sheep population and some cattle. The carrying capacity per acre is low, however.

The most interesting feature of this zone is the dependence of the grazing animal upon the leaves and shoots of the edible shrubs. These appear to be much more succulent, and more palatable, than the sparse grasses. The latter are fibrous, dry and stemmy, and in the late summer and autumn show no signs of being attractive to the grazing animal.

The average carrying capacity within this zone seems to be about one sheep to 12 to 15 acres, but there is also a considerable wild herbivorous fauna, including ostrich and guanaco (South American llama), all of which consume food that would otherwise be available for domestic stock. This is of course true also of areas farther south and west (Zones 1—3), wild geese being important in Zone 1.

It is improbable that any great agricultural development can take place in this zone unless expensive irrigation schemes are undertaken, and even so, the potential area suitable for irrigation is small in relation to the whole. In the absence of irrigation, it is hardly likely that any development in the near future, and in connexion with the pastoral production within the region, would have any considerable effect upon world supplies and markets.

Zone 5. The irrigation schemes in the valleys of the Chubut, Rio Negro, Senquel and others

Each of these schemes has been laid out in the zone of desert scrub (Zone 4). The Chubut valley was first irrigated by the original Welsh Colony in the nineteenth century, while parts of the Senquel and Sarmiento schemes have been developed by offshoots from the main Welsh Colony. Agriculture and horticulture are practised on the irrigated lands ; the Rio Negro district, for example, is said to produce some of the finest apples in the Argentine. As in other irrigation districts of the world, and especially those in hot climates, various salts (sal blanca and sal negra) are apt to cause trouble, unless the irrigation water is very carefully managed. Many agricultural crops are very sensitive to excess of soil salts. Australian experience, on the other hand, has shown that an ordinary grass-clover ley is less sensitive than lucerne. There is little doubt that the irrigated areas of the Patagonian valleys could be greatly developed under a proper system of alternate husbandry, and with more careful management of the water. With modern seeds mixtures, which would include subterranean clover as well as the common British clovers, coupled with proper manuring and grassland management (which includes in this case management of water applied to the land), pastures of high quality could be maintained, and excessive salinity could be avoided. At present good pastures seem to be practically unknown in the irrigation belts. The whole development has been concentrated

upon crops other than grass ; because of the sensitiveness of many of these crops to salinity, land that could have been put down to reasonably good grass has gone out of cultivation altogether.

Closer in to the main massif of the Andes there seems to be great scope for irrigation. There the water is both fresh and plentiful, and because of the higher incidence of rainfall and the cooler climate generally, as compared with the Atlantic coast, the salinity and other problems connected with irrigated land should be easier to solve. There are at present numerous small irrigation schemes along the Andes foothills and valleys, those at Leleque and Maiten (in Zone 3) being examples. Lucerne is grown, and in general there is no difficulty in keeping the land in a healthy condition and free from excessive salinity.

Zone 6. The pampa and agricultural lands of the Argentine Provinces (La Plata Basin)

(*See figs.* 14 *to* 17)

This zone includes not only the richest lands of the Argentine, but also the lands with the greatest potentiality for intensive development It includes practically the whole of the Provinces of Buenos Aires, Entre Rios and Santa Fé, with parts of Córdoba, Corrientes and eastern La Pampa.

The bulk of the wheat, maize and linseed of the Argentine is grown in this area, while practically all the prime beef that is exported to the English market is produced here. The population of sheep is high, and fat lambs are produced for export. The areas of grazing lucerne for which the Argentine has gained fame practically all lie within this zone.

In connexion with the development of the fat stock industry, it is of interest to note that this industry has been based upon a system of temporary leys, and not on the natural grasslands or permanent pastures. It is true that the natural grasslands, and semi-natural grasslands (such as the outrun lucerne leys) act as reservoirs for the rearing of store cattle, and for the breeding of herds, but it is important to realize that the prime beef comes off temporary leys of lucerne, together with oats, rye and other crops sown especially for *grazing* during the winter and early spring periods when the lucerne is not productive. The potentiality for development in this zone is tremendous.

Up to the present there has been a concentration upon lucerne growing, together with the supplementary cereal grazing crops for winter feeding. No manuring is ever done except that incidental upon the dunging and urination of the grazing animal. No supplementary feeding of the animals is practised. Grassland management is haphazard and a proper system of rotational grazing is hardly known. A correct use of modern seeds mixtures, with the inclusion of appropriate leafy strains, together with the use of Italian ryegrass and other plants such as winter crops to supplement the present lucerne and cereals would create important advances. Not only can fat cattle beasts be produced, but, if properly organized, the output of other pastoral products, including prime lamb and dairy produce, could be increased to an enormous extent.

Much of this land, such as that in the Buenos Aires Province, is still held by companies and by individuals in big holdings (the Argentine Estancias). In many districts an interesting share farming system has developed. (See also Estancia La Elena below, p. 39). The share farmer (or "chacárero") cultivates and crops the land, and shares the crop with the landowner on an agreed basis. It is, however, a condition that after a run of a number of cereal crops (such as maize, wheat and linseed), the land so cultivated has to be laid down to lucerne, and is then handed back to the estancia. The share farmer then moves on to another block of land, either on the same or another estancia. The system is interesting, particularly from the viewpoint of the estancia-holder, who is usually running fatting cattle, and who is therefore dependent upon lucerne as a feeding crop, but who as a feeder is not primarily a cultivator and welcomes the opportunity of passing on the worries of arable cultivation to others who are better equipped for that work. Some modification of this scheme might be worked with advantage in Great Britain. In many of our all-grass districts the farmer does not possess the will to cultivate, or the knowledge of cultivations to take him through arable crops. Neither very often has he the equipment and facilities to put the plough into his old grassland. Might it not be possible to develop the "share farming" scheme with the condition laid down that the land must go down to grass again with a pre-arranged statement regarding appropriate seeds mixtures and manures ?

The soils of the La Plata Basin do not appear on the whole to be acid. Spangenberg (**4**) working in Uruguay (also within this zone) quotes a number of analyses which show that soils underlying good pastures have an average pH of about 6. The calcium and phosphoric acid contents of these soils are fairly satisfactory. In other districts, however, where the pastures are less good, osteomalacia occurs in cattle. Here the soils have a pH below 5, and the lime and phosphate status is low. Clovers and other legumes are usually entirely lacking under such conditions. Spangenberg suggests the extended use of salt licks as the remedy for osteomalacia on this type of country.

During the course of the tour, no obvious cases of osteomalacia were observed. Its presence on an extensive scale in Uruguay suggests that osteomalacia is also likely to occur in similar country in the Argentine. All this points to the weak spot in the ranch farming and cattle feeding lands of South America. Meat and bone have been sold off these lands for a generation or more, during which time nothing has been done to replenish the plant foods so lost. Ultimately, soil exhaustion will appear in one form or another. Much of the evidence collected on this tour shows that on many lands soil exhaustion is not far distant, and more or less complete exhaustion has already taken place in the blown sand areas of western Argentine. Wind and weather complete the story of devastation (refer to Zone 7 below).

Zone 7. The arid western provinces

(*See figs.* 18 *and* 19)

These were visted only along the eastern fringe of the Province of La Pampa. The interesting feature here from the grassland point of view is that lucerne has in

the past been grown in many parts of this zone, but too intensive and too frequent cultivation without return of manures has caused land depletion, and huge areas are being eroded by wind, and dunes forming in places where there was once agricultural land. It is this class of land which accounts for a considerable part of the contraction of the acreage of lucerne experienced during the past two decades. In parts of Mendoza in this zone grapes and other fruit are grown, while in other parts, and in the Provinces of San Luis and La Pampa, cattle and sheep are bred. A considerable part of this zone, including the areas of sand and eroded soils noted above, carries arid and semi-arid desert shrub.

Zone 8. Subtropical grasslands and scrub (monte)

This large area of northern Argentine was not visited. A number of tropical and subtropical crops are grown in isolated areas. Sugar cane, for example, is grown in Tucumán, while 70 per cent of the cotton of the Argentine is grown in the Chaco. Much of the land is still in forest and scrub, but there are patches of open grassland, either natural, or following partial deforestation by man. The area may be regarded as a huge reservoir for raising rough stores and breeding cattle. The usual British breeds, such as Herefords and Shorthorns, have been crossed with the native (creole) cattle, the cross being freer from disease than the highly bred British breeds. The whole area is subject to cattle tick and there are stringent official regulations concerning the movement of stock southwards into the tick-free belts. The advent of tick must seriously affect the possibilities of development of the cattle industry, and with it, of possible pasture improvement within the area. The greater part of this zone is unlikely to be suitable for sheep.

DETAILED NOTES ON INDIVIDUAL STATIONS VISITED

A. THE PATAGONIAN STATIONS

1. Fenton Station* (Mr. Gus Yonge)

(*See figs.* 1 *and* 2)

Fenton Station covers 60,000 acres of land and carries 25,000 sheep, excluding the season's crop of lambs which number annually about 9,000 to 10,000. Corriedales are the chief breed of sheep on the station, although the influence of the Romney, and to a less extent the Merino, still remains. It was the Romney which formed the basis of the first expansion of sheep farming in southern Patagonia. The two main sources of station income are from wool and carcass. Forward lambs and a proportion of mutton sheep are despatched to the freezing works at or near Punta Arenas. The greater part of these products, both wool and carcass, goes to the London market. It is claimed that Patagonian lamb and mutton compare favourably with any from New Zealand, and there is some suggestion that the Patagonian products are sold in Britain under the general trade name of "Canterbury" lamb and mutton.

Fenton Station is fairly typical of well-managed sheep stations on the Magellan coast. There is no arable cropping whatever, and no use is made of the plough. The farming is typical ranch grazing on large paddocks. A few cattle are kept with a view to pasture control. Ponies and light horses are reared for shepherding and other farm work. There are two sharply contrasting types of natural pasture on the station, and indeed within each individual paddock (fig. 1). The greater part, perhaps representing 95 per cent of the whole area of the station, is in characteristic undulating ridges on which the soil is dry and where the grasses are in the main of the tussock or bunch grass type. On some of these ridges there will be "heather" (*Empetrum rubrum*), sometimes small bushes, including the Fachinal bush (*Chiliotrichum diffusum*), and sometimes small trees (*Nothofagus* spp. and/or *Berberis* spp.).

The following are examples of the botanical composition of this type of camp :—

(a) Chiliotrichum dominant

Chiliotrichum diffusum	60
Empetrum rubrum	20
Festuca spp.	10
Other species (including vega and califat=*Berberis* spp.)	10

See also footnote next page.

100

There was a large proportion of bare surface soil.

*The number here given with each of the stations and estancias corresponds to the number shown against their position on the map (page 49).

(b) Empetrum rubrum dominant

Empetrum rubrum	50
Baccharis magellanica	20
Festuca spp.	5
Azorella spp.	5
Berberis spp.	3
Chiliotrichum diffusum	5
Cotula spp.	Traces
Various lichens	5
*Other species	7
	100

There was approximately 35 per cent of bare surface soil.

Vegas occupy a smaller proportion of the grazing lands and represent only about 5 per cent of the total area. The vegas are flat expanses of valley grasslands developed probably upon old lake bottoms. They carry dense matted "grassy" turfs which are at most periods of the year kept closely grazed by sheep. The aggregate per acre sheep-carrying capacity of the vegas must be very high, judging by the way sheep tend to congregate upon them, and this short, sweet herbage is in many places almost lawn-like. Legumes are entirely absent; the small rush (*Juncus scheuchzerioides*) is an invariable constituent, and in many places the dominant in the sward. Not only do sheep find the vega swards palatable, but also great numbers of wild geese (showing close affinity to the Falkland, or Upland, goose) congregate on these pastures. The wild goose is obviously a troublesome pest inasmuch as it consumes large quantities of palatable and nutritious feed that would otherwise be available for sheep. A good vega will carry from two to three sheep (with lambs) in the summer and one to two sheep per acre throughout the winter. The following shows the botanical composition of the swards on two vegas at Fenton Station (recorded 15/3/38)

(a) Vega (very closely grazed)

Juncus scheuchzerioides	45
Carex spp.	10
Deschampsia antarctica	5
Cotula sp.	5
Juncus sp. and *Marsippospermum* sp.	Trace
Hordeum jubatum	5
Festuca rubra var.	10
"Burr" and other species not identified	20
	100

Bare spaces: nil.

*Among other species recorded on Fenton Station were the following:—

Agrostis tenuis, Poa pratensis, Festuca magellanica, Poa annua, Alopecurus antarcticus, Deschampsia Kingii, D. caespitosa, D. antarctica, D. flexuosa, Calamagrostis poaeoides, Stipa humilus, Elymus valdiviae, Trisetum spicatum, Hordeum jubatum, Juncus scheuchzerioides, Carex macloviana et al., *Atropis biflora, Marsippospermum grandiflorum, Anarthrophyllum desideratum, Verbena tridens, Lepidophyllum cupressiforme, Prosopis alba, Adesmia boronoides.*

(b) Vega (not grazed closely)

Deschampsia caespitosa (a soft, leafy and palatable form)	40
D. Kingii (not so robust as above, but soft and eaten)	8
D. antarctica	3
Juncus scheuchzerioides	15
Hordeum jubatum	4
Festuca rubra var.	15
Cotula spp. ?	10
Other species, including *Carex* sp.	5
	100

Bare spaces : nil.

A point of incidental interest is the high proportion of tussock grass (*Deschampsia caespitosa*) in the vegas not closely grazed. This species is native to Britain, being regarded as a troublesome weed of clay land and other pastures. The British and usual north European form is strikingly harsh and unpalatable, but the form* found on the vega at Fenton Station was soft to the touch, and obviously highly palatable to sheep. Swedish workers have developed a non-harsh form of *D. caespitosa*, which they claim will be a valuable addition to species used in their moorland reclamations. *D. caespitosa* grows as a wild plant on many of our British moors, and an improved form might be useful in hill improvement. Observations have recently been made on various wild forms of *D. caespitosa* growing in Britain. Although the usual form is harsh and wiry, there are frequently to be found plants that are distinctly soft to the touch and these appear usually to be more palatable than the average coarse form. During the spring of 1940, a sub-stoloniferous form with "soft" leafage was collected on The Delph near Lakenheath, (Suffolk), and brought to Aberystwyth for further study.

Some parts of the vega are distinctly wet and in need of drainage ; many have been drained in the past, while some simple schemes of drainage are now in process of completion.

The burning of grassland is a common practice on many sheep stations in the Magellan zone, but it is doubtful if the practice as carried out is wholly sound. It is agreed that too frequent burning of " camp " causes rapid deterioration in the sheep carrying capacity of the pastures, and the poorness of some patches of "camp" is said to be due to the frequent burning done by native Indian tribes perhaps a century or more ago. The vega pastures are usually so well grazed that there is no need to use the firestick to control roughage. It is the drier ridges which are most often burnt for the purpose (allegedly) of freshening up the growth, and of destroying the accumulated dry and inedible roughage. It is on these dry ridges that most harm is done by fire, and there is frequent evidence of the topsoil being burnt, with serious results. Usually Fachinal bush will recover quickly after being fired, but the fescue tussock grassland degenerates quickly after a succession of fires. The British grasses, Yorkshire fog and cocksfoot, established well on the burn, and there is some evidence that the native sheep's fescue (*Festuca magellanica*) spreads temporarily at least.

Herbaceous legumes (clovers and clover-like plants) do not occur in the native

*So far as could be judged this "soft Chilean form" is true *D. caespitosa*. An expert systematic botanist might, however, not agree with my nomenclature.

grasslands on Fenton and other stations in the same locality. There are one or two shrubby legumes among the native flora, but these do not appear to play any major part either in stock nutrition or land improvement. White clover was found growing in a few places along roadsides on the Magellan coasts, but none in the general grasslands of the sheep stations (fig. 2).

2. The Freezing Works at Tres Puntes

The freezing works (frigorifico) at Tres Puntes was inspected. It lies just out of the town of Punta Arenas on the Straits of Magellan. Sheep, of course, comprise the main slaughtering, but small numbers of both pigs and cattle are also dealt with. It is to this freezing works that the consignments of sheep are sent from the Falklands. In both 1937 and 1938 (about March of each year), boat-loads of live sheep were shipped from the Falklands to Tres Puntes for killing and freezing. The carcasses go direct to the London market, where the Falklands have a small import quota. It was with a boat-load of such sheep that I travelled from the Falklands to Tres Puntes (a not altogether unpleasant experience), and I saw this consignment slaughtered and placed in the freezing chambers. The Tres Puntes " frigorifico " is among the smaller of its kind. A more complete account of modern South American " frigorificos" is given later in this report, in dealing with an inspection made of the Anglo Frigorifico at Buenos Aires.

3. Sierra Castillo (Manager, Mr. Greer)

(*See figs.* 3 *and* 4)

The sheep station of Sierra Castillo extends over some 130,000 hectares (= about 310,000 acres), and carries normally about 125,000 sheep. The station is owned and occupied by the Sociedad Explotadora de Tierra del Fuego, one of the largest of the Chilean pastoral companies, which also has pastoral interests in the Argentine. The rainfall averages about 30 in. per annum, considerably heavier than the rainfall along the Straits of Magellan, which lie over one hundred miles to the south-east of Sierra Castillo.

This station lies on the eastern foothills of the Southern Andes (Cordilleras) in Chile, and on the eastern fringe of the montane forest area where the southern beech (*Nothofagus* spp.) is the predominant forest tree. A large part of the grazing lands is natural grass steppe, sometimes free from shrubby growth, as on the vegas (valley flats) and sometimes with low bushes, as on the lower and easier slopes and hillsides. Many of the hills are clad in forest and are relatively little used for grazing. The peaks and the higher mountains are still the home of the condor (eagle), the puma (South American lion) and other wild life which make sheep farming in the mountains precarious, if not impossible. All the highest peaks of the Cordillera in this region are permanently snow-clad. The country has the typical ruggedness of the European Alps, but in many ways, including the vegetation, shows closer affinities with the southern alps of New Zealand. Many of the highest peaks, for example, tower from a base which is little above sea level, and there are often wide, and agriculturally valuable valley flats at their bases. This in effect gives the Cordillera a majesty which surpasses that of the European Alps and shows up their towering peaks to better advantage.

As was noted at Fenton Station near Punta Arenas, the vega or valley flats at Sierra Castillo provide very valuable summer grazing lands. In the vegetation of the vega, predominantly grassy though it is, the small rush (the grass-like *Juncus scheuchzerioides*) often contributes largely to the herbage. This herbage is almost everywhere kept short, forming a close dense sward with a few dominant species and a restricted flora generally. Because of the heavy falls of snow which are experienced each winter (June to August), the vegas with their short swards are quite useless for winter grazing. During the winter, therefore, reliance is placed upon the fescue and *Poa* tussock grasslands.

One or two fields around Kark settlement (on Sierra Castillo station) sown with British grasses and clovers have on the whole proved successful. Among species that have been outstandingly good and highly productive in these leys are cocksfoot (probably of New Zealand origin), Yorkshire fog (probably sown as an impurity in cocksfoot), alsike clover and white clover (much of it of the larger-leaved type). One would infer from the general behaviour of such leys as were seen that there is considerable scope for the sowing of British seeds mixtures, always including wild white clover, in selected areas of the foothill country of the Southern Andes. With the extended use of such leys, this region would add to its capacity as a producer of fat lamb for export, and such an extension of ley farming might even form the basis of an entirely new dairying industry in this area.

White clover appears to thrive as a wayside and thicket plant in these localities, and sets seed freely. At the time of my visit to Sierra Castillo, white and alsike clovers were in full flower, and a few of the clover heads had already set seed. The pollinating agent appears to be a large bee, quite different in colour from any of the common British bees. This observation is important from the viewpoint of conditions in the Falkland Islands. In the latter colony, there are no bees or other pollinating agents and the clovers do not therefore set seed (**1**), although flowering is profuse. It has always been alleged that the climate of the Falklands is too severe for bees to live in the wild state. The evidence from Patagonia and Southern Chile, where wild bees certainly exist in quantities sufficient effectively to pollinate clovers, would suggest that the appropriate bee might well be successfully introduced and maintained in the Falklands. The climate of Southern Patagonia is more severe than that of the Falkland Islands as regards the incidence of wind, low winter temperatures and snowfalls.

Marram grass (*Ammophila arenaria*) planted on certain sandy areas on Sierra Castillo has been successful in stabilizing moving sand.

4. Las Vegas Station (Manager, Mr. Werner)

This station of approximately 160,000 acres carries some 40,000 sheep, or about one sheep to four acres. Like that at Sierra Castillo the station is the property of the Sociedad Explotadora de Tierra del Fuego. Las Vegas lies within the Argentine Republic in the Territory of Santa Cruz, and in the valley of the Rio Coyle. The rainfall is from 10 to 12 in. per annum, and the climate definitely arid. The general vegetation is grass steppe, typical tussock grassland with only occasional patches of shrub steppe (with mata negra).

5. Chymenaiki Station (Manager, Mr. Grimwood)

(*See figs.* 5 *and* 6)

This station lies a few miles to the south of the port of Gallegos (the most southerly port on the mainland of the Argentine), and a few miles inland from the Atlantic coast. The rainfall is about 10 in. per annum, the summer is fairly dry and for a period hot ; the winter is long, with considerable snow. High persistent winds during the whole of the spring and summer are a feature of the climate. Chymenaiki covers about 100,000 acres, and carries 25,000 sheep (one sheep to four acres). The sheep are predominantly Corriedales developed upon an original Romney Marsh base to the flock. The wool crop averages 9 lb. of wool per sheep and the lambing percentage is about 100 on the average.

There are three types of natural camp on the station, namely,

(*a*) Tussock grassland with belts of shrubs (califat and mata negra) (*See fig.* 5)

(*b*) Vega—large areas of flat land with large (fescue ?) tussock-forming grasses intermixed with *Hordeum murinum* et al. (*See figs.* 5 *and* 6)

(*c*) Cañadon—narrow valley flats between low hills.

Tussock grasslands, group (*a*), with scrub occupy the greater proportion of the areas, but there are also vast areas of vega grassland. The cañadon occupy only a small aggregate area, but they are probably the most easily improvable. Some of these cañadon are liable to flood in winter and early spring. The surface soil is very dry and powdery, and there is a gravel subsoil. The present vegetation is of an annual nature (much *Hordeum murinum* and *H. jubatum* ?)

None of these grasslands contains any trace of herbaceous legumes. No proper trials have ever been conducted here, but there seems no adequate reason why lucerne (especially certain hardy forms), alsike, suckling clover, white clover and *Medicago lupulina* should not thrive in selected areas and under proper management. There is evidence within the area that lucerne and trefoil can both be grown under proper cultural treatment (see also notes later). Management of pastures and the natural grazings is likely to play an increasingly prominent part in the ranching system as time goes on. Although wool is still the most important crop grown on these stations, recent years have seen a growing interest in fat lamb production. Freezing works (frigorificos) have been erected at many of the Patagonian ports, and deal chiefly with fat lamb and fat mutton. There is also a considerable store sheep trade ; the stores are "live-shipped" northwards to the La Plata Provinces where they may be used either for breeding or for immediate fattening.

6. Condor Station (Manager, Mr. A. T. Waldron)

This station of 500,000 acres carries about 120,000 sheep, or again, one sheep to 4 acres. Wool is the main product of the station, the average annual wool clip is about 9 lb. per head, and a lambing percentage of 80 is normally expected. The sheep are predominantly Corriedales, and Corriedale crosses, but with obvious remains of the original Romney base. The owners are Messrs. Waldron and Wood of London.

The average rainfall is about 12 in. per annum, but there is considerable varia-

Fig. 1.
SOUTH PATAGONIA (Straits of Magellan). Vega and tussock grasslands at Fenton station.
Left. Vega carrying short dense "grassy" swards.
Right. Tussock grassland (steppe) with Fachinal bush (*Chiliotrichum*) in foreground.

Fig. 2.
SOUTH PATAGONIA (Straits of Magellan). "Fence-line ecology" near Fenton station.
Left. Short dense grassy swards on road verges which are excessively grazed, trodden upon and manured by passing livestock.
Right. Field of tussock grassland (steppe) under normal range management.

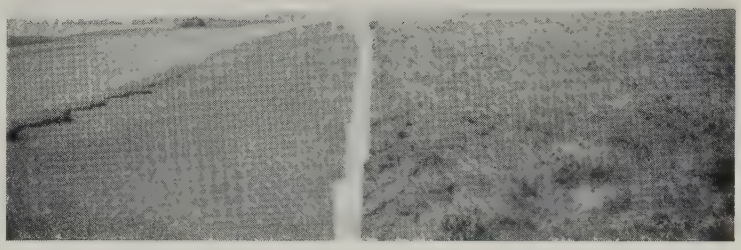

Fig. 3.
SOUTH PATAGONIA (Chilean Andes). View in the foothill country, at Sierra Castillo station.
Back. Sierra Castillo mountain (summit 4,000 ft.). Note (*a*) patches of beech forest (*Nothofagus*) in gullies; (*b*) alpine grasslands, (*c*) cliffs and screes.
Middle distance. Vega (short grass valley flats).
Foreground. Tussock grassland (steppe) with some shrub.

Fig. 4.
South Patagonia. A clearing in the beech (*Nothofagus*) forest, near Penitente, South Chile.
Fore. Pastures with cocksfoot, white clover and other European plants including the herbs.
Back. Partially cleared forest with cocksfoot well established on the forest floor.

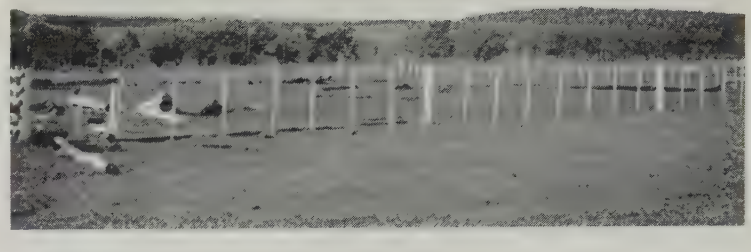

Fig. 5.
South Patagonia (Gallegos), at Chymenaiki station.
Fore. Vega flats in tussock grassland.
Back. Ridges of tussock grassland with mata negra shrub (*Verbena tridens*).

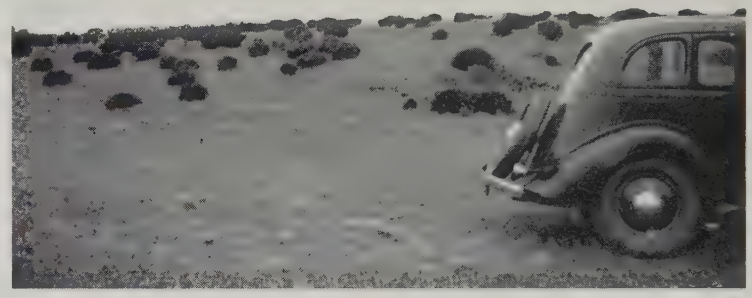

Fig. 6.
South Patagonia (Gallegos) at Chymenaiki station.
Close-up of tussock grassland on the vega flats—the chief grasses are *Poa* spp. and *Festuca* spp.

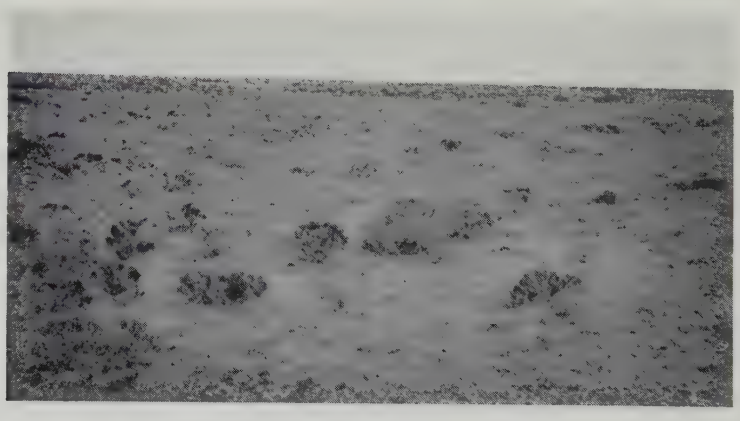

Fig. 7.
South Patagonia (Santa Cruz) near Luiz Piedro Bueno.
General view shows the Santa Cruz River and expansive pampa characteristic of Southern Patagonia.

Fig. 8.
South Patagonia (Santa Cruz) near Luiz Piedro Bueno. Closer view of pampa vegetation (grass steppe with low shrub). The shrubs are chiefly mata negra (*Verbena*) and ratstail (*Lepidophyllum*).

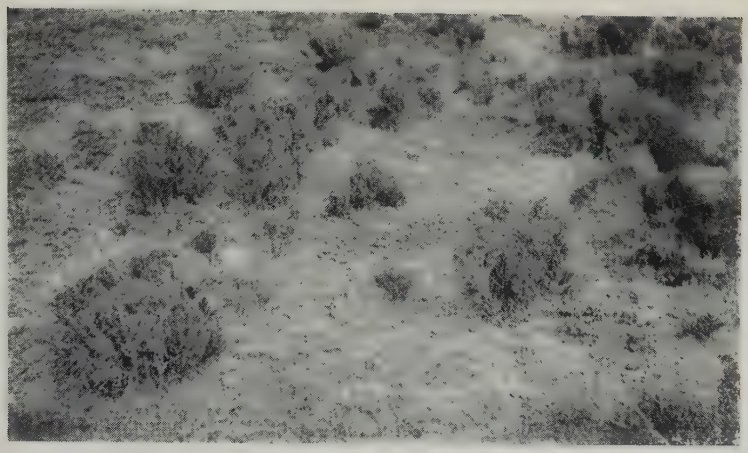

Fig. 9.
Mid-Patagonia (Chubut). Shrub steppe near Comodoro Rivadavia.

Fig. 10.
Mid-Patagonia (Chubut) near Comodoro Rivadavia. Closer view of shrub steppe. Note lack of grasses and the large proportion of bare ground.

Fig. 11.
North Patagonia (Andes foothills) near Pilcañeu station, Rio Negro.
Tussock grassland with yellow bush or neneo (*Verbena* sp.). Hereford cattle passing along the main road (picado).

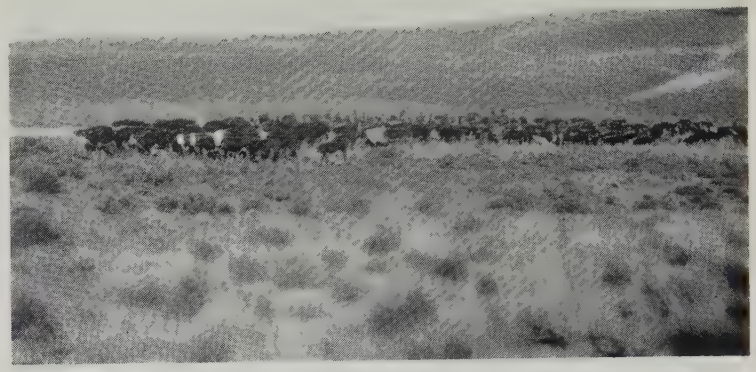

Fig. 12.
North Patagonia (Andes foothills) at Pilcañeu station.
Australian type Merino rams on tussock grassland with yellow bush, or neneo (*Verbena*).

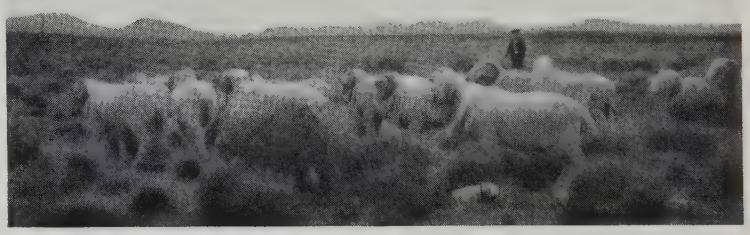

Fig. 13.
North Patagonia (in the Andes) at Llao Llao near Bariloche, Rio Negro.
Clearings made in the rain forest carry swards composed chiefly of European grasses, clovers and herbs.

Fig. 14.
ARGENTINE PROVINCES (Entre Rios) at Los Yuqueries station.
"Cross-bred Herefords" on semi-natural grassland (steppe). *Paspalum* spp. and associated subtropical grasses form the basis of these swards. Legumes (chiefly *Medicago lupulina* et al.) occur in small amount.

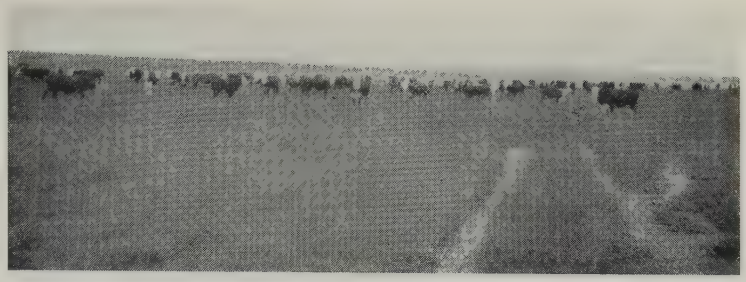

Fig. 15.
ARGENTINE PROVINCES (Entre Rios) at Los Yuqueries station.
Tick-infested cattle brought in for (fortnightly) dipping.

Fig. 16.
ARGENTINE PROVINCES (Buenos Aires) at La Catalina station.
Three year old lucerne ley showing five weeks growth (of practically pure lucerne) ready for grazing.

Fig. 17.
Argentine Provinces (Córdoba) at Laguna del Monte station.
First quality Hereford cattle being fattened on a 4-5 year-old lucerne grazing ley.

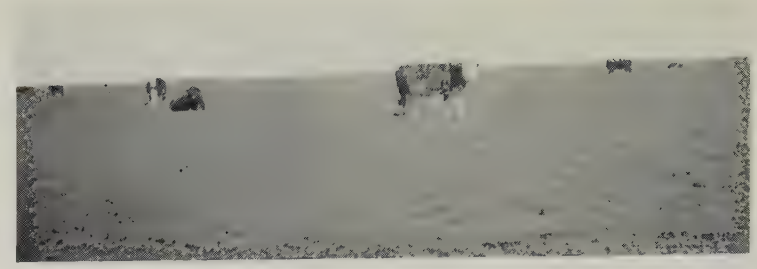

Fig 18.
Argentine Provinces (La Pampa) near Rufino.
The depleted lands—at one time in cultivated lucerne, but now more or less sandy wastes.

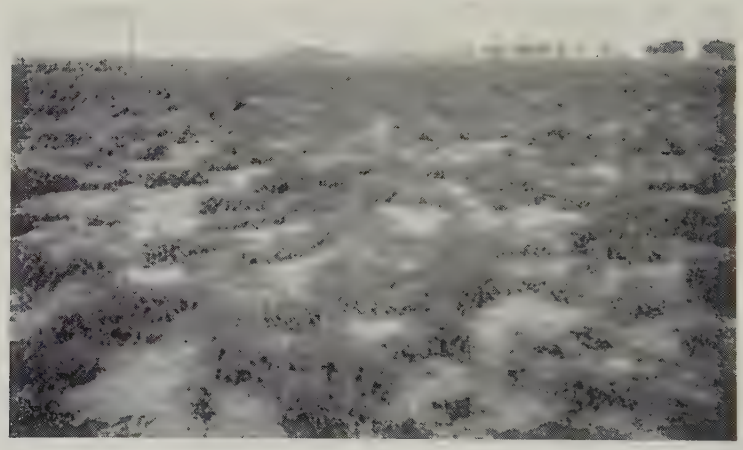

Fig. 19.
Argentine Provinces (Buenos Aires) near America.
A main road in the depleted lucerne country. Note motor tracks made in the still moving sands which have covered the roadway.

tion from year to year. The 1936-37 rainfall totalled, for example, only a little over 8 in. for the full year. The station lies on the Chilean border in the far south-east of the Argentine and extends to Cape Virgins on the Straits of Magellan.

There are five different types of natural grazings on Condor Station as follows :

(*a*) Tussock grasslands with occasional scrub (califat and mata negra)
(*b*) Tussock grasslands with Fachinal bush
(*c*) Diddle dee land
(*d*) Areas of blown sand
(*e*) Vega and cañadon grasslands.

The tussock grasslands with scrub, group (*a*), and the tussock grasslands with Fachinal bush, group (*b*), cover probably 75 per cent of the area. The type of country on which these occur is flat to rolling pampa, immense stretches of which can be seen from selected vantage points. Usually the tussock grasslands carry a bunch grass vegetation ; tussock plants occur every 1 to 1.5 sq. ft., with shorter vegetation between the tussocks. There is a very high percentage of bare ground. Patches of steppe shrubs occur here and there, the chief being califat (*Berberis* sp.), mata negra, and Fachinal bush. The occurrence of Fachinal bush is locally accepted as an indication of the best class of tussock land grazings. Close to the chief settlements, the tussock grasslands have been depleted by excessive grazing with sheep, with the result that an inferior vegetation is to be found. The carrying capacity of these depleted areas has been greatly reduced in consequence. The secret in successful ranch farming on these semi-arid grasslands is said locally to be twofold : (1) never overgraze, or do so only if no other practical alternative offers itself, and (2) rest completely from stock for one to two years periodically. There is a good deal of evidence to support these views.

The diddle dee land, group (*c*), extends over about 100,000 acres, representing about one-fifth of the aggregate area of Condor Station. From the grazier's stand-point, diddle dee land is practically worthless in its present state. The herbage is low growing, and, apart from the diddle dee bushes, is very scanty, containing only a minimum of grasses and no legumes. There is usually a high percentage of bare ground. The underlying soil is a thin sandy loam and in places very gravelly. It dries out, therefore, very rapidly and it would be dangerous to plough (although it lies in easily ploughable expanses) without previously building up the humus content and the soil body in general. If ploughed in its present state there would be grave danger of erosion under the influence of the persistent high winds from the west. A better scheme would probably be to "scratch" drastically with grass harrows (of the "Aitkenhead" type) and sow a seeds mixture containing say, Yorkshire fog, rib-grass, *Danthonia*, *Bromus inermis*, suckling clover, white clover and trefoil.

Blown sand and shifting dunes, group (*d*), occupy considerable areas on Condor Station, especially in that part of the Station along the Argentine-Chile frontier. This sand is very coarse grained, gravelly in places, and usually dark steely in colour. The sand has been encroaching on valuable tussock grasslands. Where the covering is not deep, and the tussocks are not completely killed off, there is remarkable recovery of the vegetation, which appears to be rejuvenated as a consequence of the light sanding. Where the sand is deep, and forms dunes, the natural grasslands are com-

pletely denuded and/or killed off. Plantings of marram grass (*Ammophila arenaria*) and sea lyme grass (*Elymus arenarius*) have been made on these areas of deep sand ; the former species is establishing itself excellently, and is conspicuously better than the sea lyme grass. The immediate problem is the stabilization of these dunes. At a later stage the question of introducing grazing plants and the proper alternate resting and grazing of such areas will assume greater importance.

The vega and cañadon, group (*e*), are represented by wide flats (vegas) and narrower valley bottoms (cañadon). The problems on these seem to be very similar the one to the other. Originally they were probably in tussock grassland, which has been depleted because of heavy grazing ; there now remains a short grass vegetation, sometimes dominantly of native species and sometimes (as where treading and manuring by sheep have been excessive) largely in barley grass and other annual vegetation, of which at least part is exotic in character. On certain small areas near the main settlement at Condor, lucerne has been successfully established in enclosed fields, and grown without manuring or inoculation of seed. Two good cuts of hay may be obtained in the year. The plants were found to be robust and healthy at two years old, and the stand was fairly free from weeds, although no harrowing or other surface cultivation had been done. An adjoining ten-year-old lucerne ley was full of grass and other weeds, but the individual lucerne plants still remaining were well grown and healthy, although the stand was very thin. Since no surface treatment had been given, the ten-year-old lucerne ley was very interesting, indicating that lucerne is definitely a potential forage crop in this district. This ley may be considered quite as good after ten years as would be a lucerne ley of similar age and under continuous hay in alternate years in recognized good lucerne country anywhere. One further point of interest is that lucerne was making a voluntary and unsown appearance in a strip of enclosed tussock grassland adjoining this ten-year-old ley.

The following statement shows the estimated botanical composition of some of the "grasslands" on Condor Station at the time of my visit (19/3/38).

(a) Fescue tussock grassland (grass steppe)

	Per cent.
Festuca spp. (tussocks)	45
F. ovina var. *magellanica*	10
Trisetum spicatum	5
Deschampsia flexuosa	5
D. caespitosa et Kingii	5
Luzula sp.	3
Azorella sp.	3
Acaena spp.	3
Gnaphalium sp.	1
Taraxacum sp.	1
Viola sp.	2
Other species (unidentified)	17
	100
Bare space	10

Summary

Grasses	70
Herbs	13
Woody plants	nil.
Unidentified	17
	100

(b) Fescue tussock with Fachinal bush (shrub steppe)

	Per cent
Festuca (tussock)	55
F. ovina var. *magellanica*	10
Trisetum spicatum	5
Chiliotrichum diffusum	5
Phleum spp. (? native)	2
Taraxacum sp.	5
Luzula sp.	2
Other species (unidentified)	16
	100
Bare space	5

Summary

Grasses	72
Herbs	7
Woody plants	5
Unidentified	16
	100

(c) Diddle dee type

	Per cent
Empetrum rubrum	80
Baccharis magellanica	5
Pernettya pumila	3
Festuca (tussocks) spp.	5
F. ovina var. *magellanica*	trace
Other species (unidentified)	7
	100
Bare space	15

Summary

Grasses	5
Herbs	nil.
Woody plants	88
Unidentified	7
	100

7. Moyaiki Chico Station (Owner-occupier, Mr. E. H. Jamieson)

This station lies a little to the north of Gallegos, on the main coastal motor road to Santa Cruz. It is about 25,000 acres in area and carries about 4,000 sheep, or about one sheep to six acres. High class stud (pedigree) Corriedale sheep form the basis of the flock, the best of them being exhibited annually at the chief agricultural shows of Patagonia, and at Buenos Aires. "Sheep-rugs", the Australian types, are being used extensively on this station, with a consequent improvement in yield and quality of the wool.

The rainfall at this station is about 8 in. per annum. Tussock grasslands with excess of scrub (mata negra) forming a shrub steppe type predominate, but there are considerable areas of vega (flat areas of tussock grasslands more or less free from shrubs, namely, grass steppe). The station owner had made experimental sowings of white clover, lucerne, yarrow, *Agropyron repens* and *Bromus inermis*, all of which

appeared to be fairly successful on vega. Lucerne was excellent on a small patch of irrigated land, conspicuously better with than without inoculation. In the settlement garden, perennial ryegrass, red clover, trefoil, subterranean clover, Hubam clover and white clover were all growing well.

It has been said that the main grassland type on this station is shrub steppe with mata negra as the dominant shrub. During the growing season the sheep live chiefly on the grasses and herbs, but during the winter months they eat the younger shoots of the low bushes as well as pickings of grass growing in the lea of the shrubby vegetation. In order to keep the shrubby growth under control, flame throwers were being used to burn off the bushes and to thin them out. This is a recent development of some interest in relation to ranch farming on shrub steppe lands generally.

8. Coronel Station (Manager, Mr. Arthur Blake)

This station is owned by the San Julian Sheep Farming Co., a private company in the hands of the Blake family (descendants of the Somersetshire Admiral Blake). The family has large interests in the Falkland Islands as well as in Patagonia. Coronel Station lies a few miles inland from the town and port of San Julian. The station is among the largest in the district, extending over some 350,000 acres and carrying about 60,000 sheep, roughly one sheep to 6 acres. Highly bred (including pedigree) Corriedales provide the basis for the flock, and the average wool clip is about 8 lb. per head per annum. Stud sheep from this station are exhibited at agricultural shows throughout the Argentine ; numerous photographs of notable prizewinners among Coronel sheep provide an interesting and permanent mural exhibit at the homestead.

The average rainfall for the thirteen years 1925 to 1937 inclusive at Coronel Station was 11.1 in. ranging from 4.9 in. (1927) to 15.8 in. (1933). The variation from month to month is not as wide as might be expected in so arid a climate. Table 1 shows the monthly rainfall for the four years 1932, 1933, 1935 and 1936.

Table 1.—Monthly rainfall at Coronel Station, San Julian, for four years.

(By courtesy of Mr. Arthur Blake.)

Month.	1932	1933	1935	1936	Average for four years.
January	0.90	1.00	1.10	0.67	0.91
February	0.90	0.90	0.18	0.60	0.64
March	0.30	0.40	0.08	0.36	0.28
April	4.00	1.00	0.87	1.56	1.86
May	0.20	2.10	1.39	1.43	1.28
June	0.70	4.50	1.20	0.20	1.65
July	2.40	0.50	1.96	1.43	1.57
August	0.30	1.50	1.80	2.14	1.43
September	0.60	0.20	0.65	0.66	0.52
October	0.70	0.70	1.15	0.69	0.66
November	0.30	1.10	1.43	0.20	0.76
December	0.90	1.90	2.10	0.20	1.27
Total	12.20	15.80	13.91	9.54	12.83

These records relate to rainfall at the main settlement of Coronel Station, and the rainfall here may well be higher than that of the station as a whole. Comparing the vegetation on Coronel Station with that on stations in the vicinity of Gallegos (Condor, Chymenaiki and Moyaiki Chico) the general impression is one of greater aridity at Coronel. The grassland on this latter station consists roughly of 50 per cent pampa, 40 per cent bajo and 10 per cent cañadon, all of which types present marked features of aridity.

The pampa consists of large undulating tracts of grass steppe with patches of shrub steppe. The general type shows relationships to the tussock grasslands of the Gallegos countryside, but (at San Julian) the tussock grasses form a lower proportion of the whole, while woody and semi-woody plants, many of them edible, are altogether more important features of the vegetation. The bajo represent large flat expanses, probably old glacial beds, on which are scattered numerous salt lagoons. These lagoons dry out completely in summer and are quite bare of vegetation. The dominant "grassland" type of the bajo is shrub steppe (figs. 8 and 10). The open canopy of scrub stands at a height of about 3 to 4 ft., many of the elements are prickly and even spinous, some are edible and produce a part of the "grazing" ration, but a few of the shrubs are distinctly poisonous (e.g. mata venenosa). The stock carrying capacity of the bajo areas must be considerably lower than that of the pampa.

The third group, cañadon, or gully grasslands, occupy a much smaller area of the station than does either the pampa or the bajo. Many of the cañadon carry a rich deep alluvial soil, sometimes quite black. Chemical analyses of the soils (made by the Argentinian Dept. of Agriculture, Buenos Aires), indicate that they are all supplied with phosphate, potash and lime (the pH value of one such sample was 7.6), but that the available plant foods may be below average. The nitrogen content is not high. The summer water table stands at about 4 feet, and even in the driest weather these soils will be moist.

Lucerne, perennial ryegrass and trefoil were all growing well in cañadon fields close to the main settlement at Coronel. One stand of lucerne was 25 years old, but had become very weedy (chiefly gramineous weeds) because of the lack of harrowing and other cultivations. Considerable scope exists, however, for intensive development of certain selected areas within these valleys.

9. Lochiel Station (Manager, Mr. A. Townsend)

This station is in the territory of the Chubut, and only a few miles inland from the small port of Camarones. Lochiel is approximately 450 miles by motor track direct north from San Julian. It is about 140 miles to the north of Comodoro Rivadavia (the site of the chief petroleum wells of the Argentine) and a similar distance south of Trelew, the chief town in the Welsh Colony of the Chubut Valley.

Lochiel Station is about 370,000 acres in area and carries 55,000 sheep, or only about one sheep to 7 acres. The average annual rainfall is about 12 in. In the period 1927-1937 it ranged between 7.10 inches (1927) and 16.75 inches (1931). Table 2 shows the rainfall in inches during each three monthly period from 1934 to 1937.

Table 2.—Rainfall during 1934-1937 : Quarterly totals in inches. Lochiel Station.

(By courtesy of Mr. A. Townsend, Manager).

Period	1934	1935	1936	1937	Average
Summer (January to March)	4.44	2.75	0.36	3.70	2.81
Autumn (April to June)	3.10	2.15	9.30	1.62	4.04
Winter (July to September)	1.42	4.57	2.62	2.86	2.87
Spring (October to December) ..	4.07	3.34	0.76	4.40	3.14
Total	13.03	12 81	13.04	12.58	

The dominant type of vegetation at Lochiel, and in the surrounding countryside, is shrub steppe with far fewer grassy elements than in the more southerly stations of Patagonia. Lochiel therefore shows greater aridity even though the total annual rainfall is slightly higher than at either San Julian or Gallegos. This greater aridity is a function of latitude, Lochiel being latitude 45°S. while San Julian is 49°S. and Gallegos almost 52°S.

The following is a statement of the botanical composition of an area of shrub steppe at Lochiel.

	Per cent.
Shrubs* (edible and non-edible)	44
Grasses (including tussocks)	38
Other species, including herbs	18
	100
Bare space	61

*Including mata venenosa (poison bush) and malas espinas (spiny bush)

Analyses of somewhat similar types of shrub steppe made at various points along the road from San Julian to Lochiel are given in Table 3.

Table 3. —Typical examples of shrub steppe in the territories of Santa Cruz and Chubut (figures in percentage).

	A	B	C	D
Shrubs (over 6 in. high)	50 } 86	38 } 64	34 } 51	82 } 82
Woody "herbs" (edible—chiefly "ratstail")	36 }	26 }	17 }	— }
Grasses (including tussocks)	14	26	49	10
Other species (herbaceous)	nil	10	—	8
	100	100	100	100
Bare space	64	70	75	63

A. 90 miles north from San Julian

B. 130 miles north from San Julian, and about 15 miles south of Biedma

C. 210 miles north from San Julian, and about 20 miles north of Jaramillo

D. 250 miles north from San Julian, near Caleta Olivia (60 miles south of Comodoro Rivadavia).

The vegetation exhibits a number of interesting features ; there is a very high proportion of shrubby growth, none of which, however, is much more than 5 to 6 ft. high and is usually only about 2 to 3 ft. in height (figs. 9 and 10). Some of the shrubby material, for example ratstail, has a prostrate habit of growth. The leafage and young shoot tips of most of these shrubs (both tall and low growing) are edible and provide a not inconsiderable part of the diet of the livestock. The proportion of grasses is seldom high in these areas of shrub steppe while in some cases the aggregate contribution of all herbaceous plants (including the grasses) may be very low—14 per cent in example A, and 18 per cent in example D shown above. Sheep stations situated on this type of country carry on the average only about one sheep to 6 to 15 acres. In addition, however, there is a considerable wild herbivorous fauna, including in particular guanaco (the South American llama) and the ostrich. Judging by the numbers of these animals seen during the motor journey through Patagonia, they must reduce appreciably the actual number of domestic animals that can be effectively maintained, merely by virtue of the competition for herbaceous food.

The soil profile at Lochiel. At Lochiel, as well as over very large areas of the shrub steppe lands of central Patagonia, the surface of the ground is covered with smooth glossy pebbles. These pebbles are usually rounded, about the size of partridge eggs, the largest usually smaller than ordinary hen eggs. The first impression is that the vegetation is growing in stone and gravel. The intense gloss on these pebbles is probably due to the long continued action upon them of the persistent grit-laden winds of the Patagonian landscape. Opportunity arose at Lochiel to study the soil profile. Below the upper layer of pebbles (only an inch or two deep) was a foot of coarse sandy loam grey-brown in colour and full of rounded pebbles, the largest of which were about three inches in diameter. Below this was the subsoil which differed from the top twelve inches in being slightly lighter in colour, but contained practically no stones. The character of the subsoil did not appear to change to a depth of at least a dozen feet.

10. The Chubut Valley (irrigated)

The first area colonized by the original group of Welsh settlers lies in the lower reaches of the Rio Chubut. This area was originally part of the shrub steppe region (figs. 9 and 10), but the valley has been developed by means of irrigation works and a variety of crops have been grown. Wheat, maize and other cereals are still grown over an extensive area of the lower Chubut Valley. Good quality apples and other fruit are also grown. The holdings are small and the life of the present day settlers seems to be a hard one ; many of the farmers in the irrigation valley also hold sheep on non-irrigated land farther up country (to the west.) Although the present population of the Chubut Valley is largely Argentine-born and has never visited Wales, they all appear to speak excellent Welsh. They have two languages, namely, Welsh and Spanish, and have no knowledge of English. They retain an intensely religious outlook upon life and maintain the religious forms of nineteenth century Wales. There are other Welsh colonies at Lago Sarmiento, Esquel and 16 de Octubre ; the first of these lies some 100 miles inland from the port of Comodoro Rivadavia, while Esquel and 16 de Octubre are both in the Andes near the upper reaches of the Chubut River.

Time and the exigencies of local motor transport did not permit a stay of more than half a day in the main irrigation settlement around Trelew, Gaiman and Dolavon. The other three Welsh colonies mentioned above were not visited. The standard of grassland farming in the Chubut is extremely poor. There has apparently been no attempt to adjust the demands of irrigated lands towards a proper pasture concept. This is somewhat surprising since the irrigated lands have become saline. Salts, both black and white, encrust the surface and make arable crop production difficult and in places impossible. Similar areas of saline soils were seen in the valley of the Rio Negro near the towns of Carmen de Patagones and Viedma.

Australian experience has been somewhat similar in connexion with the Murray River irrigation schemes. The Victorian (Australia) Department of Agriculture has eased the situation by the use of grass-clover leys which are less susceptible to salinity than lucerne and the arable crops in general. Good results have been obtained in Australia by making sowings of a mixture of Wimmera ryegrass and subterranean clover for use as a grazing crop. The Wimmera ryegrass-subterranean clover mixture requires only the minimum of watering once it has become properly established. Two important advantages of this ley are (1) it has a dormant period during the hot summer thus needing no watering in those months when saline salts tend to rise most rapidly to the surface, and (2) the crop can regenerate itself annually from seed. The general impression gained is that the Chubut and other South American irrigation schemes would benefit a great deal if full use were made of the knowledge and general experiences gained years ago by irrigation authorities associated with the Departments of Agriculture in Australia.

11. Leleque Station (Manager, Mr. Weaver)

Leleque Station, the property of the Argentine Southern Land Co. Ltd., lies at the foothills of the high Andes in the north-west corner of the Territory of Chubut. It is, therefore, some 300 miles from the Atlantic coast, but no more than 100 miles (as the crow flies) from the Pacific seaboard ; that is, the Chilean coast. The Station covers some 415,000 acres ; 70,000 sheep (Australian Merino) are shorn each year, and in addition there are 4,500 Shorthorn cattle and about 1,400 horses (Creole crosses—riding and light draught). The total carrying capacity of Leleque is the equivalent of about one sheep to four acres. The "lowlands" of Leleque are some 2,000 ft. above sea level, while the higher points in the sierra (mountain) rise to 8,000 and 10,000 ft. The average rainfall is about 18 in. per annum, and there is in addition an annual average of 18 in. of snow.

The sheep are of the Australian Merino type (as distinct from the Argentine Merino) and are kept mainly for the wool crop. The Shorthorn cattle are kept for breeding and also to supply the local beef requirements of the Station itself. All steer calves at 6 to 15 months old are sent to other farms of the Company in the Province of Buenos Aires where they are made into forward stores, or fattened off. All female calves are retained on the station for breeding. Horses are bred for use on the Station and also for supplying riding and light draught horses for the other stations operated by the same Company. For production of riding horses the

Creole ("native") mares are crossed with hackneys and thoroughbreds. For the production of light draught horses Clydesdale sires are used on Creole dams. Mules are also used for draught purposes and here the ass sires the Creole mare. Leleque is the main horse breeding station on the Company's properties and has to supply all the horse requirements of the other stations.

The distribution of the different types of grazings at Leleque is as follows :— 90 *per cent* of the area is in grass steppe with a good proportion of low shrubs ; this type shows close affinity with the southern grass steppe and tussock grasslands with mata negra found in the far south of Patagonia. The actual species making up these grasslands, however, are not those of the south. Replacing the mata negra and other southern shrubs, the common Leleque shrub is neneo (yellow bush). *Approximately* 5 *per cent* of the area is in rich vega, which shows agronomic affinities with the vegas of Southern Patagonia, but again the individual components differ from those of the south. The Leleque vegas (or valley flats) are richer in species and contain a few legumes including "a sainfoin-like sward-forming legume" (probably *Adesmia* sp.), while in places, especially adjacent to the water courses, wild white clover grows in profusion. Some of these valley grasslands are grazed very closely and among the miscellaneous herbs, *Erodium cicutarium*—also common to similar swards in Australia—was noted as being extremely palatable. *Erodium* belongs to the group of forbs (rosette herbs), many, if not all, of which are particularly rich in minerals, including lime, phosphates and potash. Pampas grass (*Cortaderia selloana*) is found growing wild on these areas of vega. It forms large tussocks, but is not considered of any particular value for stock. In recent years this species has been found useful in New Zealand where it is being increasingly employed to provide winter fodder. At Leleque the vega is regarded as providing the most valuable grazings on the Station, but of course their contribution to the stock carrying capacity is limited by the fact that they contribute to no more than about 5 per cent of the total area of the Station. *The remaining* 5 *per cent* of the acreage of the Station is occupied by the high and extremely steep sierra, many of them permanently snow-capped, and some rising to a maximum height of 10,000 ft. above sea level.

In addition to the foregoing types of natural grasslands, there are about 600 acres of irrigated land on Leleque Station, on what was formerly vega, or ordinary valley grassland. The chief crop under irrigation is lucerne, numerous haystacks of which were to be seen scattered about on the irrigated fields. There is little doubt that first-class pastures of the ryegrass, cocksfoot, timothy and white clover type could be grown here under irrigation. There are also indications that improved grasslands could be maintained without irrigation. *Phalaris tuberosa*, *Bromus inermis*, cocksfoot, Yorkshire fog and other grasses could probably be established, while among the legumes, white clover, red clover, trefoil and lucerne are all probably suitable. The winters may be too cold and severe for subterranean clover. The notes made at Leleque confirm to a marked degree the impressions gained at Sierra Castillo (in the foothill country of the Chilean Andes near Punta Arenas), that there is scope for a more intensive pastoral and agricultural development along large

stretches of the Andes. The problem of dealing with irrigated pasture and crop lands is far simpler in the Andes than say in the lowlands of the Chubut. Water is more plentiful, and is probably a good deal less saline than near the eastern seaboard, as around Trelew or Carmen de Patagones. Furthermore, the summer temperatures are not so high and the need for using vast quantities of water per acre is less than in the hotter and drier summers of the coastal lands.

12. Maiten Station (Manager, Mr. McKinnon)

Only a short stop was made at this Station, another property belonging to the Argentine Southern Land Co. Ltd., (the owners of Leleque). The Station lies about 30 miles to the north of Leleque and is in similar country in the Andes foothills. There are huge vegas, parts of which are irrigated and grow lucerne. Lombardy poplars have been planted and are a feature of the vegas close to the settlement at Maiten. The Station carries stud Hereford cattle and supplies bulls to other stations of the Company's property. Near Maiten, wheat (non-irrigated) was being grown by a Turkish farmer, who is said to be most successful in his endeavours.

13. Pilcañeu (Manager, Mr. W. C. G. MacKinnon)

(*See figs.* 11 *and* 12)

Pilcañeu is the headquarters station of the Argentine Southern Land Co. Ltd., and Mr. W. C. G. MacKinnon, who is general manager of all the stations, is also resident manager at Pilcañeu. Although Pilcañeu lies at about 3,000 ft. above the sea, it is some miles east of the Andes foothills proper, in the transition zone between the mountains and the large semi-arid plains of Central Argentine. The station lies within the Territory of Rio Negro, on the railway line from Bariloche (the Andean health resort) to San Antonio and Buenos Aires.

Pilcañeu Station covers about 92,000 acres and 25,000 sheep are shorn annually, roughly one sheep to 3.5 to 4 acres. It is one of the smallest estancias of the owning Company, but of the sheep stations it is said to have the heaviest carrying capacity and to shear the best wool. Only about 300 cattle and the usual station horses are kept apart from the sheep. The sheep are first-grade Australian Merinos (fig. 12). Romneys and Romney crosses were carried in the past, but these have now been replaced entirely by Merino. The present lambing percentage is about 75 (the Romney used to give 100 per cent lambing figures). The average annual wool clip is between 10 and 11 lb. per sheep. Fine wools are grown and the average wool count is sixty-four, but Pilcañeu cannot compete with Australian superfine wools because there is a marked tendency to excess of " condition " in Pilcañeu wool.

The annual rainfall at Pilcañeu (average 1927-1937) is 11 in. with 22 in. of snow in addition. The two main types of natural grassland are (1) grass steppe (figs. 11 and 12)—tussock grasslands, with shrubs, chiefly neneo (yellow) bush, representing probably 95 per cent of the whole area, and (2) valley grasslands or vegas, called locally "mallin". These valley grasslands occur on moist and fertile flats and generally carry a grassy, short and dense herbage, similar in type to that on the vegas of Southern Patagonia. There are two important differences, however, namely, the flora of the "mallin" is (a) more varied and (b) contains legumes as well as a variety of edible herbs not to

be found on the southern vegas. On one typical "mallin" examined at Pilcañeu, Yorkshire fog, sedges, rushes, dandelion, cranesbill (*Geranium molle*), storksbill (*Erodium cicutarium*), trefoil (*Medicago lupulina*), and in places wild white clover, were among the exotic plants. In places these species dominate the swards. It is probable that the summer carrying capacity of these valley grasslands is well over one sheep per acre. In the winter they are too wet and cold for stock and therefore are used only as summer grazings, but as such are an extremely valuable asset. Lucerne is grown successfully on certain of the flats near the settlement at Pilcañeu (without irrigation), while *Melilotus alba* and *Bromus unioloides* have both been grown. As at other centres there is evidence to suggest that a certain amount of intensified pastoral farming could be developed on selected sites at Pilcañeu.

The major area of grass steppe is on rolling and sub-hilly country and does not (in the absence of irrigation at least) appear to offer much scope for the development of a more intensive agriculture. A good deal, however, could be done by an improved technique of grazing management. Ill-considered and indiscriminate burning of the vegetation, for example, does a tremendous amount of harm to the sub-arid vegetation. What is apparently required is a form of "singeing", the burning of all dead leafage without creating enough heat to injure either the rootstock and green leafage or any seeds lying on the surface of the ground. Ideally, too, the burn should be selective, for many of the edible shrubs, valuable assets in these grazings, do not recover after burning.

14. Bariloche and the Andean Valleys

San Carlos de Bariloche is a fair-sized town lying on the shores of Lago Nahuel Huapi, a large mountain lake in the Argentine Andes. The surroundings are not unlike those found in the vicinity of the alpine lakes of the southern Alps in New Zealand. Bariloche is the western terminus of the state-owned railway which connects it with Buenos Aires. It has direct connexion also with the Chilean coast, and is therefore a centre for tourist traffic, both from Valparaiso and Santiago, in Chile, and from Buenos Aires and the Atlantic coast. The countryside is one of great splendour, the steep-sided Andes are clothed in natural pine and cypress forest, with the usual secondary growths indicative of high rainfall conditions. The summits of many of these mountains are in perpetual snow, while on others there are huge bare screes above the tree line. Bariloche is some 40 miles west of Pilcañeu, and is at the eastern limit of the mountain rain forest. To the west of the town, rain forest predominates, while immediately to the east sub-arid grass steppe occurs. The change from one vegetation type to the other is very rapid and probably conforms closely to the incidence of rainfall. Similar sharp lines of change are to be seen in the vegetation of the South Island of New Zealand as one proceeds in an east-west direction across the southern Alps.

The chief interest of the belt of rain forest country to the west of Bariloche lies in the herbage of fields and small clearings (fig. 13). Wild white clover abounds everywhere in these clearings, and the pastures carry a typically British flora. The following statement will illustrate this point; it shows the botanical composition of a small pasture field, and a roadside verge.

Percentage botanical composition (Bariloche—Llao Llao road). 30th March 1938.

	Pasture	Road verge
Trifolium repens	8	20
Holcus lanatus	3	5
Bromus mollis	2	—
Poa annua	—	8
Bromus unioloides	—	5
Poa pratensis	5	—
Plantago lanceolata	15	5
P. media and *P. major*	1	5
Hypochoeris radicata	22	18
Rumex acetosella	8	5
Taraxacum officinale	10	17
Geranium molle	3	2
Veronica officinalis	Trace	—
Acaena sp.	20	5
Other plants	3	5
	100	100
Bare space	20	5

B. THE STATIONS OF THE ARGENTINE PROPER

15. Estancia Los Yuqueries (Manager, Mr. A. Strachan)

(*See figs.* 14 *and* 15)

This station lies in the La Plata Basin in the Province of Entre Rios, in about latitude 31°S., near the town of Concordia, a river port on the Argentine (right) bank of the Rio Uruguay. The station, which is the property of Messrs. Liebig, covers some 22,000 acres and carries 10,000 cattle in summer and 5,000 in winter. At the time of my visit (4th April, 1938) there were 7,000 cattle on the station. No sheep are grazed. The cattle are of an extremely mixed type, including Herefords and Hereford crosses, Creole cattle and all sorts of Creole crosses, including Creole × Zebu. The herds, however, do not conform to any accepted type within the main breeds of cattle. A small number are bred on the station, but the majority of these cattle are imported from the monte (= woodland) country of the more northerly provinces, including Corrientes, Sante Fé, Córdoba and others. As they are infested with cattle tick, it is necessary to dip them every 15 days during their stay on the station (fig. 15). Tick-infested cattle cannot be made prime fat. Most of these cattle beasts go from Los Yuqueries to the freezing works. The best carcasses find a market on the Continent of Europe (Italy, France, Germany and the Balkans), but practically none of these find a sale on the London market, which apparently demands an altogether higher grade of beef. The poorer carcasses go to make tinned beef and meat extracts.

The average rainfall at Los Yuqueries is about 50 inches per annum, the totals for 1935, 1936 and 1937 were 54.7, 70.3 and 48.3 in. respectively. October to March inclusive (i.e., the summer months) normally receive a much heavier rainfall than the winter (April to September), although the monthly incidence may be extremely variable. For the winter months in the period 1936-1937, the monthly records ranged from *nil* (August, 1935) to about 11 in. (April, 1936), while over the same period of years the figures for the summer months ranged between the extremes of 2 in. (November, 1936) and 12 in. (February, 1937).

The whole of the land at Los Yuqueries is flat, or only slightly rolling (fig. 14). The grazing paddocks are large, varying from about 1,000 acres to well over 3,000 acres each. Practically the whole of the 22,000 acres on the station is in grass. Occasional crops of oats and sorghums are grown (in both cases chiefly for cattle grazing). After the arable crop, the land is allowed to revert to grass, which it does almost immediately, a complete grass cover being attained in less than two years. The herbage on these leys, however, is not palatable, and it is many years before such camps can be properly grazed by stock. Such grassland does not seem to improve much with age, and has for many years a lower carrying capacity than before ploughing up. No manures are being or have been applied to these grasslands or arable crops. There is practically no conservation of fodder in the form of hay or otherwise.

The following is the approximate botanical composition (April, 1938) of a typical old pasture (probably never ploughed) at Los Yuqueries on land with a summer carrying capacity of about one cattle beast to 2 acres, and grazing about one beast to 4 acres in winter without supplementary food.

Botanical name.	Local name (if any)	Per cent
Paspalum notatum } *Axonopus compressus* }	Gramilla	60
Sporobolus indicus	Esparto grass (a group name)	2
Lepturus incurvatus		2
Stipa spp.	Flechilla	1
Piptochaetium spp.	Esparto grass (a group name)	3
Themeda (F.)	Paja colorado	3
Festuca sp. ? fine-leaved		8
Other grasses		11
Cyperus rotunda		2
Carex sp.		5
Miscellaneous plants*		3
		100
Bare spaces		20

*Including trace of a poisonous plant called locally "mío-mío" or caustic bush.

This pasture is regarded on the station as good quality camp. *Paspalum* (probably *P. notatum*) and *Axonopus compressus* are the dominant species, and the sward is preponderantly gramineous and practically devoid of legumes—an occasional plant of trefoil (*M. lupulina*) was to be seen. The general impression gained in the La Plata Basin in general was that *Paspalum* is among the most valuable of all the grasses. The soil underlying many of these grazing lands might be classed as a sandy loam with, in places, black soils of the Chernozem type. One of the difficulties in this countryside is the recurrent plagues of locusts. These are surface feeders, which defoliate everything in their path, leaving no trace of green vegetation. Attempts are always being made to deal with the locust on a national scale, but there appear to be a number of serious difficulties consequent upon sporadic migration of the pest, which moves over large areas in a short period of time. The locust is likely to be a deterrent factor in the intensification of pastoral agriculture in these districts. There are, however, great possibilities for the improvement of pastures with a view to the production of more and better quality livestock products.

16. Estancia El Rabon (Manager, Mr. J. Wanklyn)

This station of some 16,000 acres, which lies about 30 miles to the south-west of Concordia, is again owned and occupied by Messrs. Liebig. It carries 5,500 steers for fattening, plus some 5,500 sheep and 200 horses, that is, about the equivalent of one cattle beast to 2.5 acres. Rainfall and soils are similar to those at Los Yuqueries already described (the two stations are no more than 25 miles apart), but the general quality of the pastures is appreciably higher at El Rabon. This is reflected in the better quality stock (the cattle are largely Hereford type of fair average quality), together with the fact that the steers are fattened for the freezing works. Most of these cattle are killed to produce canned meat, practically none being of

sufficiently good quality for chilling and the London market. The herds are tick-infested.

As at Los Yuqueries, the fields at El Rabon are large. On one such field of over 5,000 acres a herd of 1,700 Hereford steers was grazing, all in process of being fattened for killing. Most of the pastures seen at El Rabon were closely similar in type to those at Los Yuqueries ; *Paspalum notatum* and *Axonopus compressus* were dominant, and although there was a large number of other species in the swards, the grasses composed 90 to 95 per cent of the whole flora. One point of interest noted was that adjacent to the gateways and for a distance of some fifty yards around them the sward dominant was *Paspalum dilatatum*, the species that has established itself so widely in coastal New South Wales and Southern Queensland. *Paspalum dilatatum* is a more valuable pasture grass than the common *Paspalum* of the El Rabon and Los Yuqueries pastures. Its presence as the dominant in the heavily trodden and fairly heavily dunged areas around gateways would indicate that given proper management, and perhaps purposeful manuring, pastures of *Paspalum dilatatum* could easily be maintained on these fields.

17. Estancia San Juan (Owner, Señor Romero)

This station lies about 20 miles north-west of Concordia and in the Province of Entre Rios. The countryside and vegetation are similar in type to those described at Los Yuqueries and El Rabon. Hereford cattle are bred and other stock consist of a relatively few sheep (Romneys). The pastures are dominantly *Paspalum* (*P. notatum* ?) and the only legume noted was a small amount of trefoil (*M. lupulina*). Most of these grasslands were very rough and overgrown by the end of the summer. The majority of the grasses were stemmy and in seed. As a normal procedure this roughage, which appears to accumulate by the end of each season, is burnt over in mid-winter (early August) and before the commencement of the new season's growth. It was noted that many of the Hereford cattle at San Juan were " scabbed " (as distinct from tick). Usually the months of June and July (winter) are said to be the worst months for " scab " in cattle and adequate dipping is suggested to be an effective remedy. " Scabbed " cattle lose condition and are difficult to fatten.

18. Estancia La Elena (Manager, Mr. Duggan)

This small property of about 2,200 acres in the rich lucerne country around Venado Tuerto at the southern end of the Province of Santa Fé lies within one of the acknowledged cattle feeding districts of the La Plata Basin where first-class stands of grazing lucerne are the basis of the industry (see figs. 16 and 17). The remarks below can therefore be applied to conditions over a considerable part of the grazing lucerne country in southern Córdoba, southern Sante Fé, southern Entre Rios and northern and central districts of the Province of Buenos Aires. The cattle are free from tick infestation throughout this first-class fatting country.

An interesting feature of the agriculture in the lucerne areas of the Argentine is the " chacra " or share-farming system. The " chacarero", or share farmer, takes a " short lease " of land on the estancia. On this a succession of crops will be grown ;

for example, the rotation may be maize, followed by wheat, then sunflower, then linseed undersown with lucerne. The share farmer pays no rent, but he has to find all seed, supply himself with implements and horses (or tractor) and do all the work connected with cultivation and harvesting. The estancia receives a pre-arranged quota, perhaps 25 per cent, of every crop harvested in the course of the rotation, and there is the important stipulation that the land must be seeded down to lucerne and returned to the estancia at the end of the rotation. The agreement then terminates, and the share farmer will enter into a fresh agreement, either taking up new land on the same estancia or moving off to another estancia to repeat the process.

This system seems to be an altogether favourable one to the owners of the estancias. Their sole contribution is that of supplying the necessary land, and in return they not only have a financial interest in the arable crops, but they are assured of a continual supply of new lucerne leys on which to fatten their cattle. From the viewpoint of the grazier, this continual supply of fresh high-class lucerne leys is of the utmost importance.

At La Elena, opportunity arose to study the development of the lucerne leys from the period of establishment until they become outrun (containing little or no lucerne). Lucerne is sown in the spring (say August) either with a cover crop such as linseed, or without a nurse. If without nurse, the mowing machine is run over twice and perhaps three times during the summer in order to control annual weeds. In the autumn of the seeding year one such ley (sown without nurse) showed the following percentage botanical composition :—lucerne, 65 ; weeds, 35. Bare space, 40.

The weeds were largely annuals and included *Setaria* sp., *Panicum Crus-Galli* et al., *Bromus unioloides*, and miscellaneous annuals. The high percentage of annuals, and of bare spaces in the seeding year, indicate a close similarity with many short-term leys in Britain.

In the course of the first harvest year, the lucerne thickens up and becomes completely dominant to the virtual exclusion of all the annuals. This is also true of the second harvest year, and sometimes also of the third harvest year (fig. 16). Many such leys in their second and third harvest years which were inspected during the tour were just pure stands of lucerne.

By the fourth harvest year, however, even the best of these leys begin to weaken, and by the end of the fifth year lucerne has largely disappeared. Perennial grasses and perennial herbs invade the leys and the lucerne is gradually eliminated completely. Analysis of a four-year-old lucerne ley used for grazing (at La Elena) was as follows :—

	Per cent
Lucerne	30
Panicum sp.	25
Bromus unioloides	15
Cynodon dactylon	5
Medicago maculata	5
Cryptostemma calendulacea	15
Other species	5
	100
Bare space	nil

Bromus unioloides (local name = " cebadilla ") is welcomed as an addition to the herbage and some graziers employ a few pounds per acre in simple mixture with the lucerne. The mixture is said to provide better quality cattle fattening food than lucerne alone. This point finds confirmation in British and other work regarding pure clover versus grass-clover mixtures. Of the other main volunteer species thistle is looked upon as a valuable plant, but *Panicum* and *Cynodon* are regarded as the worst weeds as their presence in large quantity precedes the complete disappearance of the lucerne. Spotted and other medics are also regarded as valueless and are said to indicate the rapid deterioration of the ley. They are apparently not relished by stock.

It is a popular misconception in Britain, and in other countries outside the Argentine, that once a lucerne ley is established in these rich La Plata districts, it remains a productive lucerne ley for all time. Such at any rate is the impression that is to be gained from literature, and from the hearsay of travellers. One conjures up the impression of permanent lucerne pastures and meadows, never manured and never very carefully managed. In this respect the writer at least was completely misinformed. The lucerne grazings of the La Plata Basin are essentially established and maintained on the basis of ley farming—they are temporary leys with an average life of about 5 years. Sometimes these leys will be down to grass for 10 or more years, and still contain small amounts of lucerne, but that is exceptional unless they have been very carefully treated and have not been grazed in every year. The 30 and 40-year-old lucerne-dominant leys of the Argentine must be exceptions, even if not mythical. They certainly play no material part in the agriculture and cattle feeding industries of the Argentine Provinces.

19. Estancia Laguna del Monte (Manager, Mr. T. McCargo)

This station of over 85,000 acres lies in southern Córdoba, about 12 miles northwest of the town of Rufino. About 60 per cent of the station is devoted to " chacra " (share) farming and the remainder to feeding and grazing, including the lucerne leys which " flow " in from the share farm system. The average rainfall is about 32 in. per annum, but shows considerable variation from year to year. Extreme droughts are infrequent, one of the most severe of recent years having occurred during the summer of 1937-38. This had broken only a few weeks prior to my visit in April, 1938.

The stocking on some 35,000 acres representing the grazing area of the estancia is as follows :—15,000 Shorthorn and Hereford cattle (partly fattening, but chiefly breeding, most of the steers being sold as yearlings for fattening on lucerne leys in the Province of Buenos Aires) ; 1,000 sheep (Romney × South Down crosses), and a few horses. This represents a stock-carrying capacity of something like one cattle beast to 2—2.5 acres, which is about the normal stocking on the good cattle fatting lands of the Argentine provinces. The fields at Laguna del Monte are large, and average 1,000 to 1,200 acres each. These are acknowledged to be too large, a better size being about 400 to 500 acres, regarded from the viewpoint of efficient management of stock and pastures. The herds are free from tick.

The lucerne pastures at this station are either sown without a nurse crop or with wheat, and sometimes linseed, as cover crops. The usual time of sowing is March to May (that is, autumn). It will be remembered that spring sowing of the lucerne was preferred at La Elena. The lucerne ley is not grazed until almost a year old ; lucerne makes a full crop practically weed-free during the first to third harvest years (fig. 17), and on exceptional fields may be maintained almost pure until the fifth harvest year (one such field inspected in its fifth year was 90 per cent lucerne). By the seventh harvest year all traces of lucerne have disappeared. In the outrun lucerne leys, *Panicum*, *Paspalidium*, *Cynodon* and other subtropical grasses tend to dominate, while the medics (*M. denticulata*, as well as *M. maculata* and *M. lupulina*) are the chief, and often the only leguminous elements. These grassy outrun leys usually carry dense swards with little bare ground. Once the lucerne has been lost they cease to be fattening leys and gradually revert to what is termed locally " natural grasslands". More properly described they are " induced exotic grasslands " in which *Cynodon* and *Panicum* rather than the indigenous grasses of the pampa predominate.

A very interesting feature among the farming practices on Laguna del Monte is that autumn-sown cereals are used as winter and spring grazing crops for fattening cattle. Oats and rye are the favourite crops sown specifically to provide out-of-season feed, but barley and wheat may also be used. The cereal is autumn sown, and if pasture growth in the following spring is well advanced, the cereal may not be grazed, but carried on to be harvested as a cash crop. More usually it will be required for spring grazing by cattle, after which it will be ploughed up and the land sown to some other crop. No artificial manures whatever are used in the production of either crops or leys on the station.

20. Estancia San Foin (Manager, Mr. Green)

The station has an area of 25,000 acres, and carries 10,000 head of cattle. It is situated within a few miles of the town of Buchardo and in the north-west corner of the Province of Buenos Aires. The average annual rainfall is about 32 in. per annum (as low as 16 in. in 1937). Shorthorn and Aberdeen Angus cattle are bred and also fattened on the station. Fattening is based largely on lucerne leys, outrun leys and winter cereals for grazing. The latter (usually rye or oats) are sown in mid-March (autumn) and are expected to be ready for grazing within 6 to 8 weeks after sowing. Lucerne lasts as a fairly pure stand for 4 to 5 years, but is entirely lost by the seventh harvest year. The outrun lucerne ley is grassy, dominated by *Cynodon dactylon*. The outrun ley will keep animals in breeding condition, but they will not fatten. The species has only a summer grazing value for it is more or less completely winter dormant. It is also dormant during the height of summer, the local name of Easter grass (Easter occurs in the autumn) signifying that *Cynodon* makes fresh green growth after the advent of the autumnal rains. A few of the outrun leys appear to be dominant *Paspalum dilatatum*, and these are considered to be valuable grazing fields not to be reploughed while they maintain productivity. The *Cynodon* fields are reploughed with a view to sowing again to lucerne leys after a

short period of cropping. Sudan grass (*Sorghum*) is grown on this station as a forage crop for summer and autumn feeding. There is no tick infestation at this station.

The natural pampa vegetation was originally tussock grassland, grass steppe with shrubs and bushes. The older outrun leys show no return of the natural grassland species, but an induced exotic sward appears in which *Cynodon dactylon* is usually the dominant element.

21. Estancia La Catalina (Owner, Señor Arturo Brown)

(*See fig.* 16)

This station is situated in the Buenos Aires province near the town of General Villegas. It is 26,500 acres in area and carried the following stock (1938) :—8,000 Shorthorn cattle (including 2,000 calves) tick free ; 1,700 sheep (Romney Corriedale crosses) ; 500 horses ; 600 pigs.

The average acreages in different types of grassland and crops on this station in 1938 were :—

	Acres.		Per cent.
Grassland :			
Young lucerne leys in full production	6,000	..	22
Mixed lucerne and grass (probably lucerne leys 4 to 6 years old)	4,500	..	17
Outrun lucerne leys (probably 7 to 10 years old)	6,000	..	22
"Natural grassland" (including outrun leys over 10 years old)	5,700	..	22
		Total	83
Arable crops :			
Rye for winter feed	1,300	..	5
Oats (winter feed and cash crops)	1,800	..	7
Wheat (chiefly cash crop)	950	..	4
Sorghum (for summer fodder)	250	..	1
	26,500	Total	17

The average rainfall at the station over the 24-year period 1914-37 inclusive was 32.8 in. with a range of from 18 in. (1929) to just over 50 in. (1914). During this period, the years 1914, 1919 and 1934 received over 40 in. of rain per annum, while in three other years (1916, 1929 and 1937) less than 20 in. were recorded. Autumn and spring are normally the most rainy periods of the year, the winter is normally dry and heavy frosts are frequent. The natural vegetation type of the district was originally grass steppe—only remnants of which are to be seen to-day —e.g., tussock-forming grasses as pasto puna and paja biscachera. As was noted at San Foin station, the present day " natural grasslands " are more properly to be regarded as " induced-exotic", since few of the species contributing to them appear in the true pampa grasslands. The *Cynodon-Panicum-Paspalidium-Paspalum* grasslands that are established on the outrun leys and similar types are therefore followers of man. Just as on the Welsh hills, the disturbance of the natural *Molinia-Nardus-Festuca* grasslands and the introduction of the grazing animal as well as cultivation result in *Agrostis-Holcus-Trifolium* grasslands, so also one finds a parallel change in the composition of Argentine grasslands when these are seriously disturbed by human effort.

A development of some interest at La Catalina is that of dairying. The station is primarily concerned with the breeding and fattening of beef Shorthorn cattle, but a dairy section has now been built up and occupies some 5,500 acres on the estancia. The general principle followed is interesting. As the beef shorthorn cows calve, the calves are paired off and two calves are put to suckle one cow, the other cow being included in the " dairy " herd and milked. There is a small dairy factory at Elordi (the local village) which deals with this milk supply, and butter is made. Judging by the odours in and around this factory one would not expect the butter to be an article of first quality. That, however, is simply a matter of factory and dairy hygiene, and does not detract from the interesting development of *producing butter fat from beef cows whose prime function on the estancia is to produce steers for fattening.*

22. The Depleted Farmlands (as around Huinca Renanco) : Córdoba and La Pampa Provinces

(*See figs.* 18 *and* 19)

In this area there are large stretches of blowing sand, land where only a few years ago good crops of wheat, sunflower, maize and lucerne were being produced. Cattle were being bred and fattened on the lucerne leys much in the manner that has been described with regard to La Catalina and other stations. In the course of the tour, part of two days was spent in these sand areas, and during both days a heavy dust storm was blowing. Although the weather was fair, the sky was thick with dust and sand. In places visibility at ground level was no more than a few yards, and the whole skyscape was reminiscent of a thick London fog.

The processes of depletion and soil erosion are obviously proceeding rapidly over large areas of this countryside. In places crops of oats, rye, wheat and lucerne are still grown and appeared to be fairly thrifty. Many *Cynodon* pastures, too, were beautifully green following upon the recent autumnal rains which had broken the force of the 1937-38 drought. In other places (and this was the more common feature of the countryside) there were huge belts of shifting sands. In parts large moving dunes were burying fences, roads and erstwhile farming land. The Argentine Department of Agriculture has taken a serious view of this erosion (by wind) problem and attempts are being made to stabilize the shifting dunes by plantations of marram grass (*Ammophila arenaria*).

The theory is advanced that the soil water table has been lowered by the taking of a succession of arable crops on this land. What is probably nearer the truth is that the land has been depleted through its subjection to so much arable cropping without properly planned replenishments of plant foods. The humus content has been depleted as well as the general level of fertility with the result that the soil now lacks body and cohesion. What would once have been described as a light sandy loam has now degenerated into a coarse-grained sand.

Official records show that the total aggregate acreage under lucerne in the Argentine has become greatly restricted during the past twenty years (say since 1920). This restriction of the lucerne acreage appears to be due quite appreciably to soil erosion in these westerly districts of the La Plata Basin. The area of depleted lands

must cover hundreds of square miles within the Provinces of Córdoba, San Luis, La Pampa and the western portions of the Province of Buenos Aires adjacent to them.

23. The Anglo Frigorifico at Buenos Aires

Half a day was spent inspecting this killing and freezing works representing one of the largest and most modern of its kind in the Argentine. Striking features were the self-contained nature of the works and the fact that nothing is wasted ; a whole series of departments forming part of the factory deal with by-products of all descriptions. Thus the surplus and waste fats are made into soap and other materials. The gelatine residues are dealt with, as are also the bones, horns, skins, blood and all sorts of offal. " Camel " hair brushes are among the many things manufactured on the spot. These appear to be made from certain selected hairs taken from the ears of cattle beasts. The factory makes its own packing cases at the saw milling department ; it makes its own tins from tin sheets and manufactures its own muslin (for wrapping sheep carcasses) on the spot. Sausages of all sizes and descriptions, sausage skins, corned beef and canned mutton are all among the by-products dealt with up to the final stage of production.

The frigorifico has its own wharves immediately adjacent to the factory where the carcasses and the whole series of other exportable materials go direct to the ocean-going refrigerating vessels.

Cattle, sheep and pigs are handled at this factory. It will be of interest briefly to describe the manner in which cattle are dealt with. They are delivered at huge covered yards resembling, on a larger scale, the cattle yards at many of our important market towns. If necessary the cattle will be given a little time in which to empty themselves, although this may not be necessary where they have come in by train over long distances.

The animals are at all times very carefully handled, and with the absolute minimum of disturbance in order to obviate their becoming bruised. When ready for killing the beasts are slowly moved into a large washing yard, with the sprinkler type of water pipes overhead. When the water is turned on, they receive a shower bath (rather resembling heavy rain) for about half an hour. They are then slowly driven up a long and steepish platform which takes them to the top floor of the factory, and the killing room. They enter this killing room in batches of three, Here three men await them with heavy sledge hammers and immediately these latter operate, the three beasts are in an instant hanging by their hind legs to an endless chain. Once on the chain their throats are cut as the first operation ; the carcass remains on this endless chain until it is halved, quartered and finally wrapped in hessian and enters the refrigerating chamber.

As it travels around the killing room it passes a whole series of men all doing one specific job, the carcass moving the whole time. It is entrailed, skinned and halved by electrically propelled saws, examined by a series of veterinary officers, some representing the Argentine Government, others employed by the Company. Carcasses showing the least sign of tuberculosis, or other disease, are discarded.

The carcasses which pass all the inspections (and the latter appear to be most thoroughly conducted) are finally stamped by the Government agents and are wrapped in hessian and go straight into the cooling chambers.

The offal of all descriptions is transferred through chutes direct to the lower floors where each type of offal is dealt with by its own specialized department. Speed, efficiency and complete lack of waste appear to be the fundamental principles on which the frigorifico is worked.

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GLOSSARY OF COMMON PLANT NAMES

Alsike clover, *Trifolium hybridum*

Barley grass, *Hordeum jubatum*
Beech, southern, *Nothofagus*

Calafat, *Berberis* sp.
Catsear, *Hypochoeris* sp.
Caustic bush, *Baccharis coridifolia*
Cebadilla, *Bromus unioloides*
Cocksfoot, *Dactylis glomerata*
Cranesbill, *Geranium molle*

Dandelion, *Taraxacum officinale*
Diddle dee, *Empetrum rubrum*

Easter grass, *Cynodon dactylon*
Esparto, *Piptochaetium* spp., *Sporobolus indicus*

Fachinal bush, *Chiliotrichum diffusum*
Fescue, native sheep's, *Festuca ovina* var. *Magellanica*
Flechilla, *Stipa* spp.

Gramilla, *Paspalum notatum*, *Axonopus compressus*

"Heather", *Empetrum rubrum*
Hubam clover, *Melilotus alba* var. *annualis*

Italian ryegrass, *Lolium italicum*

Linseed, *Linum* sp.
Lucerne, *Medicago* sp.

Malas espinas, spiny bush, Latin name unknown
Marram grass, *Ammophila arenaria*
Mata negra, *Verbena tridens*
Mata venenosa, poison bush, Latin name unknown
Mata verde, scrub, Latin name unknown
Medics, *Medicago* spp.
Mío-mío, *Baccharis coridifolia*

Native sheep's fescue, *Festuca ovina* var. *Magellanica*
Neneo, *Verbena* sp.

Paja biscachera, Latin name unknown
Paja colorado, *Themeda*
Pampas grass, *Cortaderia selloana*
Pasto Puna, Latin name unknown
Perennial ryegrass, *Lolium perenne*

Ratstail, *Lepidophyllum* sp.
Red fescue, *Festuca rubra*
Red clover, *Trifolium pratense*
Ribgrass, *Plantago* sp.
Ryegrass, *Lolium* spp.

Sainfoin, *Onobrychis* sp.
Sea lyme grass, *Elymus arenarius*
Soft brome, *Bromus mollis*
Spotted medic, *Medicago maculata*
Storksbill, *Erodium cicutarium*
Subterranean clover, *Trifolium subterraneum*
Suckling clover, *Trifolium minus*
Sudan grass, *Sorghum* sp. (=*Andropogon sorghum* var. *Sudanensis*)
Sunflower, *Helianthus* sp.

Timothy, *Phleum pratense*
Trefoil, *Medicago lupulina*
Tussock grass, *Deschampsia caespitosa*

Vega (?) *Berberis* sp.

Wheatgrass, *Agropyron* sp.
White clover, *Trifolium repens*
Wimmera ryegrass, *Lolium rigidum* Gaud. var. *subulatum* Fiori

Yarrow, *Achillea millefolium*
Yellow bush, *Verbena* sp.
Yorkshire fog, *Holcus lanatus*

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NOTE BEARING UPON THE GRASSLAND MAP

The map has been prepared with a view to its being used as a guide to the reading of the text. The boundaries shown in respect of the several grassland belts are to be regarded as approximate only. The author could find no published material to help him in the more exact determination of the boundaries. The map is therefore based in very large part upon detailed notes made on the vegetation observed and upon evidence collected from various agriculturists in the Argentine with whom these matters were discussed.

The map may be useful in so far as it indicates in a general way the distribution and relative extent of the different grassland types upon which the livestock of the Argentine are produced. It shows clearly, for example, the relatively small extent of the justly famous lucerne grazing lands of the La Plata Basin ; especially restricted are these when one considers their area in relation to the Argentine as a whole. Furthermore, within the zone in which lucerne leys are found there is still a vast acreage in semi-natural grasslands, and in crops other than lucerne. This is emphasized further when it is said that the area of lucerne leys in the Argentine is estimated at about 13,000,000 acres, whereas the chief lucerne zone, as shown in the map, contains at least 30,000,000 acres. Not all of the 13,000,000 acres of lucerne leys are within the zone outlined ; there may be several million acres of lucerne that lie outside this zone. All this serves to stress that in respect of lucerne alone (and with it the outdoor fattening of cattle for export) there remains tremendous scope for development within the rich areas of the La Plata Basin.

The route traversed, together with the chief stopping-over places during the tour, is shown in the map by a red line ; a few of the larger towns are shown also. The location of all the stations visited is indicated by numbers, referring to the key on the right. It has not been possible to include the contours on the map ; it is assumed that reference may be made to a relief map for purposes of comparison.

The question of cattle tick and tick-free areas has been mentioned in the body of the report, and the approximate boundary between the tick-infested and tick-free areas has been placed on the grassland map. Broadly, it may be stated that northern Argentine is tick-infested, while the southern areas, including the larger part of the La Plata Basin, are tick-free. The "tick-line" runs roughly east and west from the neighbourhood of the towns of Paysandu (in Uruguay), Concepcion, Santa Fé and Córdoba.

Key to Map of the Grasslands of the Argentine and Patagonia

STATIONS VISITED :

1. Fenton
2. Tres Puntes
3. Sierra Castillo
4. Las Vegas
5. Chymenaiki
6. Condor
7. Moyaiki Chico
8. Coronel
9. Lochiel
10. Trelew (Chubut)
11. Leleque
12. Maiten
13. Pilcañeu
14. Bariloche
15. Los Yuqueries
16. El Rabon
17. San Juan
18. La Elena
19. Laguna del Monte
20. San Foin
21. La Catalina
22. Huinca Renanco (erosion)
23. Buenos Aires

Andean forests including southern beech and pine forests—sheep and some cattle

Tussock grasslands of Patagonia—sheep and some cattle

Semi-arid shrub steppe—sheep, some cattle and goats

Areas of high aridity—very low density of livestock (chiefly cattle)

Sub-tropical savannah and scrub—chiefly cattle rearing

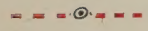
La Plata basin. Natural and semi-natural grasslands (sub-tropical type)—cattle and sheep

La Plata basin. Semi-natural grasslands with zones of intensive agriculture (wheat, maize and other crops)—cattle, including dairy, and sheep

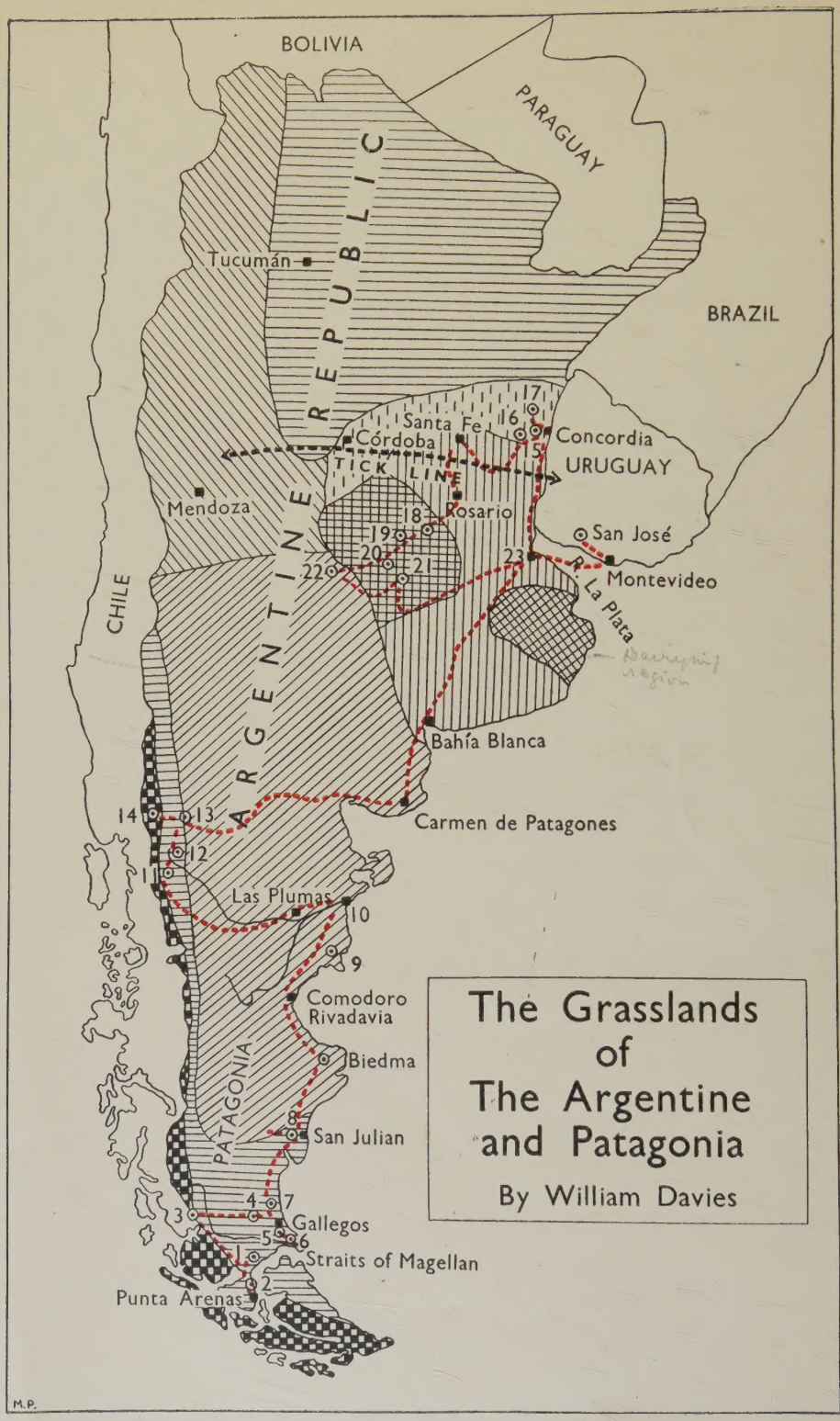
La Plata basin. Semi-natural grasslands—cattle and sheep—and including areas of lucerne leys used explicitly for cattle fattening

La Plata basin. Semi-natural grasslands—cattle and sheep

Tick line


Route followed, with chief stations to which visits were made indicated by numbers, which refer to the descriptions in the text, pp. 19-45.

Chief towns



The Grasslands of The Argentine and Patagonia

By William Davies